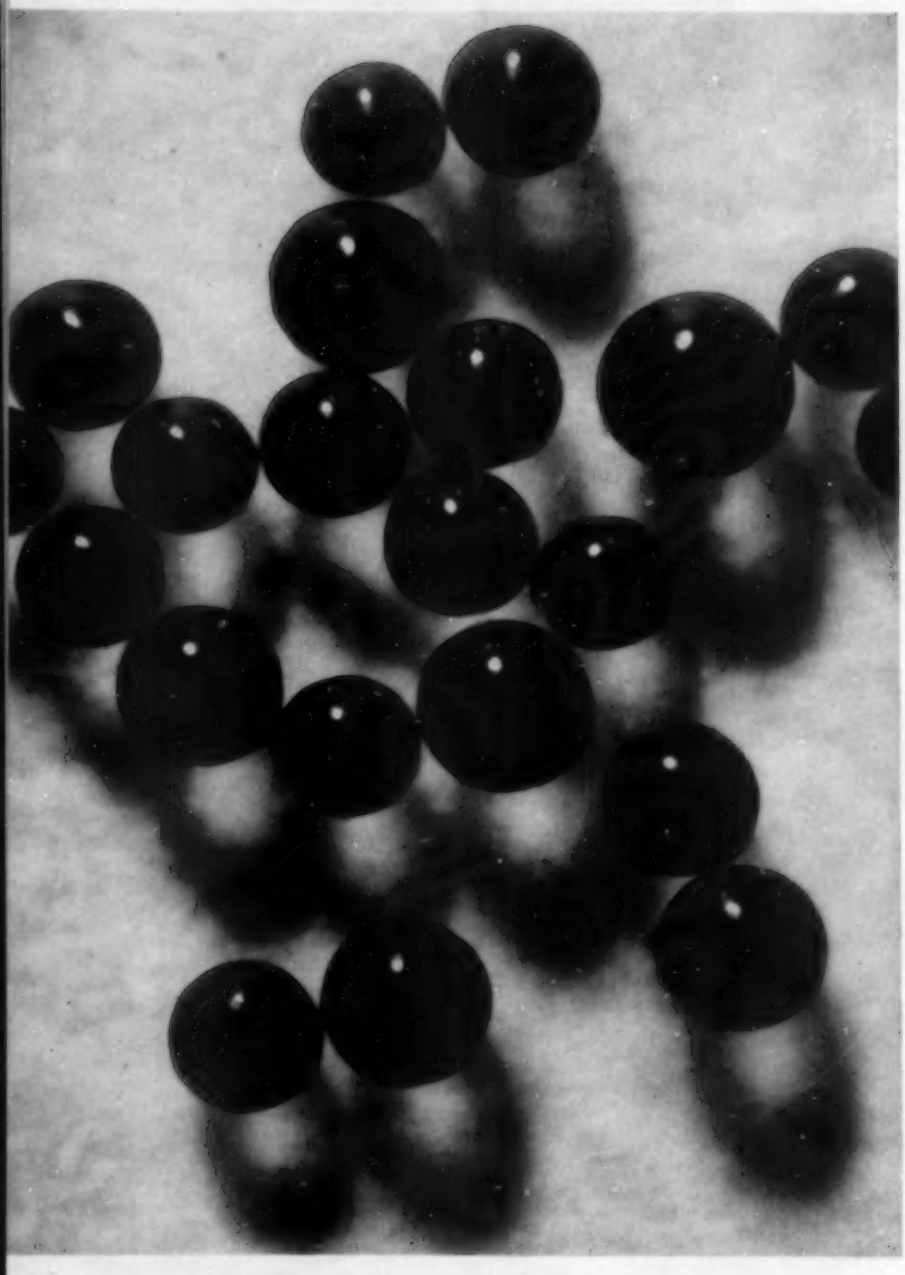
Industry and Power



October 1954

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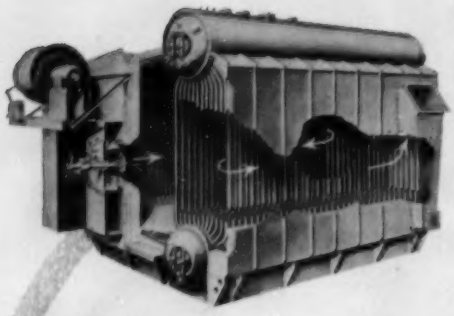
for engineers and executives responsible for

—engineered plant facilities

STANDARD BOILERS THAT SET INDUSTRY STANDARDS

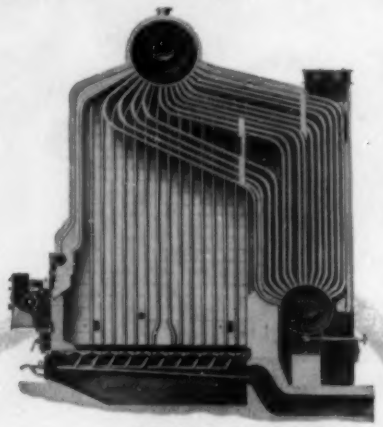
Whatever your steam needs, in the complete C-E line of fuel burning and steam generating equipment, you will find a type and size just right for you.

In the moderate capacity range, for example—from 4,000 to 120,000 pounds of steam per hour—the three *standardized* C-E Boilers shown here offer advantages of economy and performance that make them standout values in a wide range of applications.



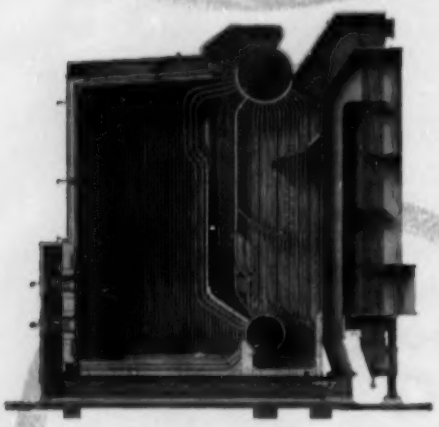
C-E Package Boiler, Type VP

4,000 to 40,000 lb steam per hr . . . pressures to 500 psi . . . for pressure firing of oil or gas . . . completely shop-assembled, needs only simple concrete slab for foundation. Has more water-cooled area per unit of furnace volume than any other boiler of its size and type. Large lower drum permits simple, symmetrical tube arrangement . . . great water storage capacity . . . easy access. Low-speed centrifugal fan is unusually quiet in operation. Simple baffle arrangement means low draft loss . . . simple soot blowing . . . no dead pockets . . . high heat absorption.



C-E Vertical-Unit Boiler, Type VU-10

10,000 to 60,000 lb steam per hr . . . pressures to 475 psi . . . superheat to 200 F in larger sizes . . . for coal, oil or gas . . . bottom-supported, needs no outside supporting steel. Boiler is efficient over a wide range of output, and is easy to operate and maintain. All parts are readily accessible for inspection. Regardless of fuel, the same general cross-sectional arrangement of drums, convection bank and furnace cooling is used. Uniform design through each transverse section assures even water level in drum, and uniform expansion.



C-E Vertical-Unit Boiler, Type VU-55

50,000 to 120,000 lb steam per hr . . . pressures of 250 or 500 psi . . . superheat and heat recovery equipment if desired . . . for oil or gas . . . bottom-supported, needs no outside supporting steel. This boiler is of symmetrical design. Thus gas temperature is constant across the full boiler width. The narrow, high furnace . . . integral design of boiler and preheater . . . absence of exterior ductwork . . . compactness—all help the VU-55 achieve standards of performance closely approaching that of large central station boilers.

Other C-E Industrial Boilers

In addition to the standard boilers shown here, Combustion offers many other 2-drum designs, for capacities to 350,000 pounds of steam per hour, for any commercially available fuel, for pressures to 1375 psi, and temperatures to 960 F. Heat recovery equipment is available. So — whatever your steam needs — call Combustion for details on the complete line of C-E Industrial Boilers.

B-747A

COMBUSTION ENGINEERING

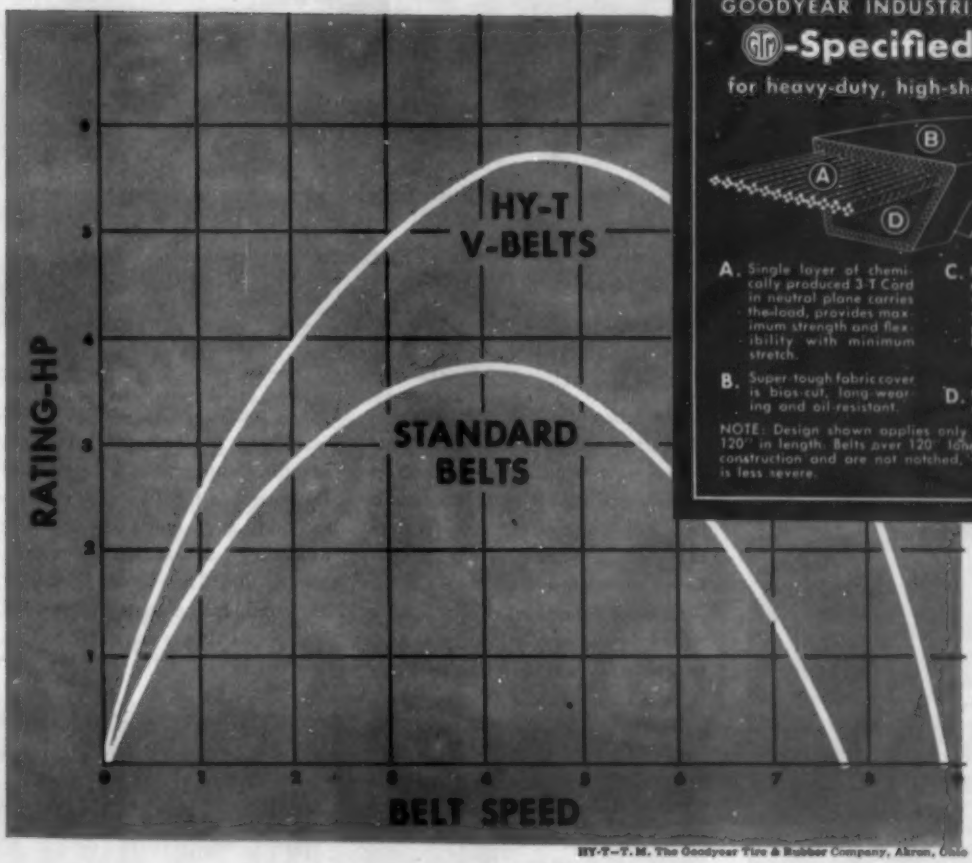
Combustion Engineering Building
200 Madison Avenue, New York 16, N. Y.

BOILERS, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE

Circle 500 on Reply Card for more data

TRIPLE-TEMPERED (3-T) CORD

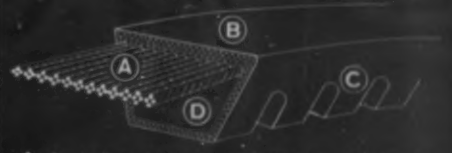
makes new, super-V-belt possible



GOODYEAR INDUSTRIAL PRODUCTS

GY-Specified HY-T V-Belts

for heavy-duty, high-shock-load drives



A. Single layer of chemically produced 3-T Cord in neutral plane carries the load, provides maximum strength and flexibility with minimum stretch.

B. Super-tough fabric cover is bias-cut, long-wearing and oil-resistant.

C. Notches close when rounding pulley to provide positive grip on sheave, open between pulleys to ventilate belt.

D. Cushion section of durable rubber.

NOTE: Design shown applies only to HY-T V-Belts under 120" in length. Belts over 120" long are of a multiple-ply construction and are not notched, since the flex problem is less severe.

3-T CORD makes the new HY-T V-Belts so strong that *seven* of these super-belts will do the work of *ten* standard belts on such tough drives as oil well mud pumps, rock crushers, metal-forming presses, pebble mills, paper and sawmill machinery—at the same cost per rated HP and with net savings on complete drives.

HY-T—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

40% HIGHER HORSEPOWER RATING without sacrifice of service life. Much higher shock-resistance. Minimum stretch. Long flex-life. Dimensional stability under all storage and operating conditions. Maximum resistance to oil, moisture, mildew and static generation. These are the properties built into the new HY-T V-Belt by the G.T.M.—Goodyear Technical Man—with the help of Triple-Tempered (3-T) Cord.

3-T Cord is the result of an exclusive and patented Goodyear process—a triple-action tempering of special synthetic cord, involving Tension, Temperature and Time, which "sets" the cord at its point of maximum strength and resilience. Using this super-strong cord as the load-carrying member, the G.T.M. built a completely new super-V-belt of completely balanced construction.

The HY-T V-Belt is designed for service on heavy-duty, high-shock-load drives or on drives where limited space previously resulted in underbelting. On such drives it has been thoroughly proved to give longer life than standard fabric belts with appreciable savings in drive and maintenance costs. For details on the super-rated HY-T V-Belt see the G.T.M. or your Goodyear Distributor. Or write Goodyear, Industrial Products Division, Akron 16, Ohio.

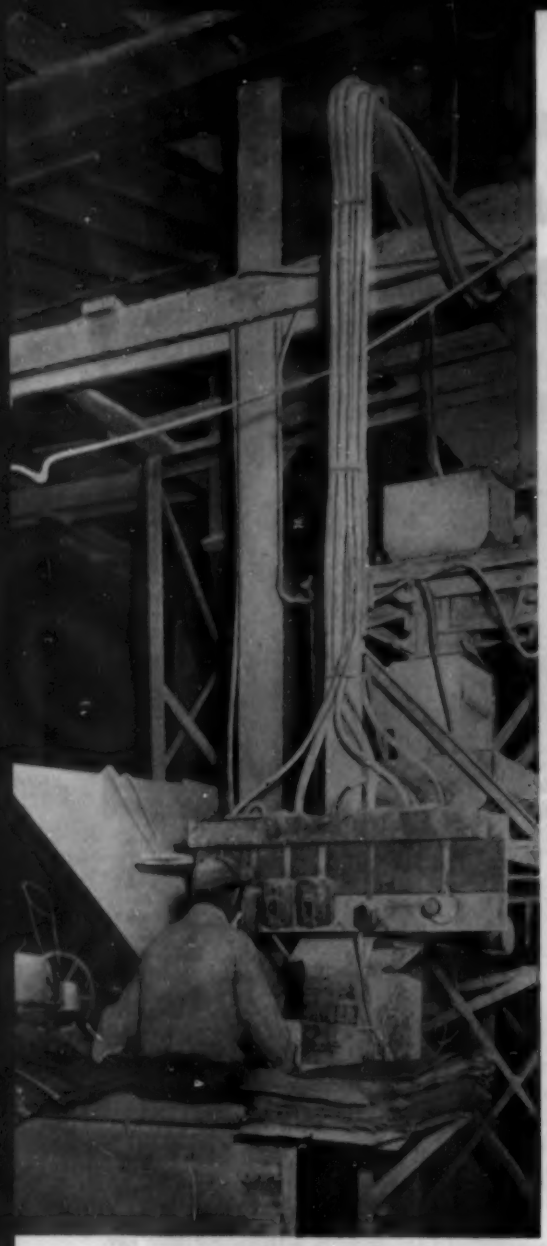
YOUR GOODYEAR DISTRIBUTOR *can quickly supply you with Hose, Flat Belts, V-Belts, Packing or Rolls. Look for him in the yellow pages of your Telephone Directory under "Rubber Products" or "Rubber Goods."*

GOODYEAR

THE GREATEST NAME IN RUBBER

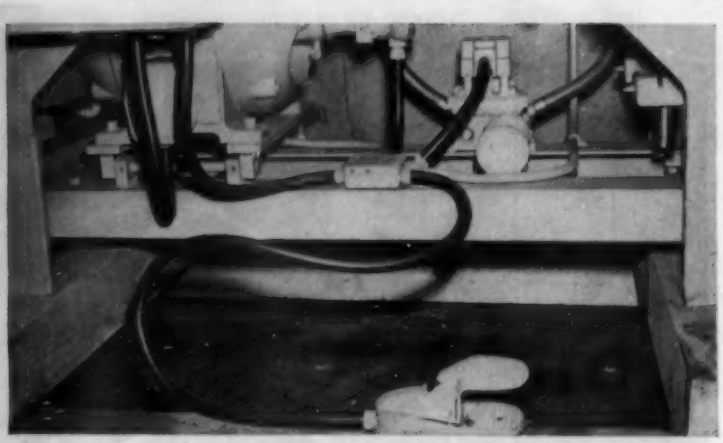
Circle 501 on Reply Card for more data

SEALTITE Flexible Electrical Wiring Conduit makes news



. . . in a fertilizer plant

Phosphoric acid in the form of dust quickly ate through neoprene covered wiring at a Midwestern fertilizer plant. Then SEALTITE Type E.F. (Extra Flexible) was installed to protect power and lighting wiring. Since then there's been no trouble. SEALTITE'S tough synthetic cover gives complete, permanent protection against moisture, oil, dirt, grease, chemicals and corrosive fumes. Lightweight SEALTITE comes in easy-to-handle coils and can be cut to required lengths.



. . . on tube end-forming machines

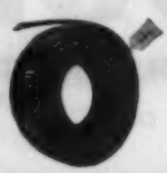
SEALTITE* Electrical Wiring Conduit is now standard equipment on all tube end-forming machines made by Vaill Engineering Co., Waterbury, Conn. Vaill found most customer specs are copies from J. I. C. — especially sections dealing with wiring in wet or oily locations. And SEALTITE Type E.F.† (Extra Flexible) meets J.I.C. requirements. "SEALTITE presents good contour-hugging appearance," says Vaill. Because it is *flexible*, SEALTITE absorbs vibration and protects wiring to moving parts. SEALTITE is easy to install, too. There's no threading. No cumbersome tools are needed. No special skill is required.

*Trademark †Pat. Applied For 54177

. . . in a yarn and knit goods dye house

American & Efird Mills, Mount Holly, N. C., knew electrical equipment in their new textiles dye house would operate under very severe corrosive conditions. At first, some rigid conduit was installed along with SEALTITE Type U.A. Acids in the atmosphere caused the rigid conduit to fail rapidly. But SEALTITE Type U.A. — the first *flexible* conduit to win Underwriters' Approval for use where exposed to moisture and mineral oils—took it in stride. Now all rigid conduit is being replaced with SEALTITE. American & Efird reports big time-and-dollar savings in installation, too.

FREE BOOKLET! Write today for your free copy of Bulletin UA-531, describing SEALTITE Types U.A. and E.F. and their applications. The American Brass Company, American Metal Hose Branch, Waterbury 20, Conn.



SEALTITE

flexible, liquid-tight electrical conduit

an ANACONDA® product

Industry and Power

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More inches of VISIBILITY . . . and No Blind Spots with NEW Jerguson STEAM GAGES

Assembly No. 618

You get more inches of visibility within centers available . . . and no blind spots with the New Jerguson Steam Gages with the horizontal expansion loop. The special new compact valve, with a *horizontal* loop that keeps the strain off the gage assembly under varying conditions of expansion and contraction, gives you maximum gage room within the centers.

The special offset single piece gage chamber design with staggered glasses and covers gives you continous visibility of the water level *with no blind spots* between gage sections.

The gage can be turned at any angle, yet there are no stuffing boxes between gage and valves. The ingenius design of the assembly includes a bracket so the gage will always stay in vertical position. The OS&Y valves have renewable seats and are standard with quick closing stem for chain operation, as shown, or available with plain closing stems and chain wheels.

Made in three designs of single piece chamber: for one, two, or three section glass for any W.S.P. Any Jerguson standard gage may be supplied with stems and flanges for use with this expansion loop valve.

Write for full information on Jerguson New Steam Gages with Horizontal Expansion Loop Valves.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY

100 Fellsway, Somerville 45, Mass.

Offices in Major Cities

Jerguson Truss Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

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acorns

. . . recently announced . . . worth watching

Pouring It On

● A giant ceramic pouring tube that can stand up under extreme temperature changes has been developed for a new pressure casting method for carbon steel.

The special refractory is being successfully used in pressure pouring the carbon steel into graphite molds to produce railroad freight car wheels. The ceramic tube or spout plays a vital role in the process by controlling the flow of molten steel from the ladle.

Magnetically Yours

● A new device, called a D-C Recording Hysteresiograph, does away with hours of laborious measurement and calculation in determining the magnetic characteristics of metal by tracing the magnetic "signature" of a metal directly onto a scaled chart in minutes.

It is believed that the device will be a valuable quality control instrument for manufacturers of special steel. Laboratories can also make use of it in obtaining accurate data on commercially available materials and in the development of new alloys of metals.

Tested Under Fire

● Fire tests carried out with 85 percent Magnesia thermal insulation demonstrate that the material will withstand a 2000 F flame for an extended period without appreciable damage and that the insulation is capable of protecting pipes and equipment under average fire conditions. The tests also indicated that during a plant fire, the insulation would prevent sudden temperature rise of the contents of the pipes and vessels exposed.

Watch Your Timing

● It has been suggested that stroboscopic discs be manufactured in plant shops and used to set the speed governors on certain rotating machinery. The discs can be used as a stroboscopic timing device in places where the faster and more accurate stroboscopic tachometer is not readily available.

Stripping the Cathode

● A unique type of cathode that functions without the power sources required by other cathodes has been developed. Associated equipment, such as filament transformers, are unnecessary with this new device. The savings effected in weight, power, heat dissipation, size, and the elimination of many insulation difficulties, will be an important factor in its further applications.

Waste Diamond Recovery

● The Industrial Test Laboratory at the Philadelphia Naval Yard has been giving special attention to diamond recovery from industrial diamond wastes. An electrostatic separator has been successfully used for separating diamonds from South African ore concentrates. The property of diamonds to accept and retain a relatively large electrostatic charge in comparison with most mineral substances is effectively used to separate them.

Strange Touch

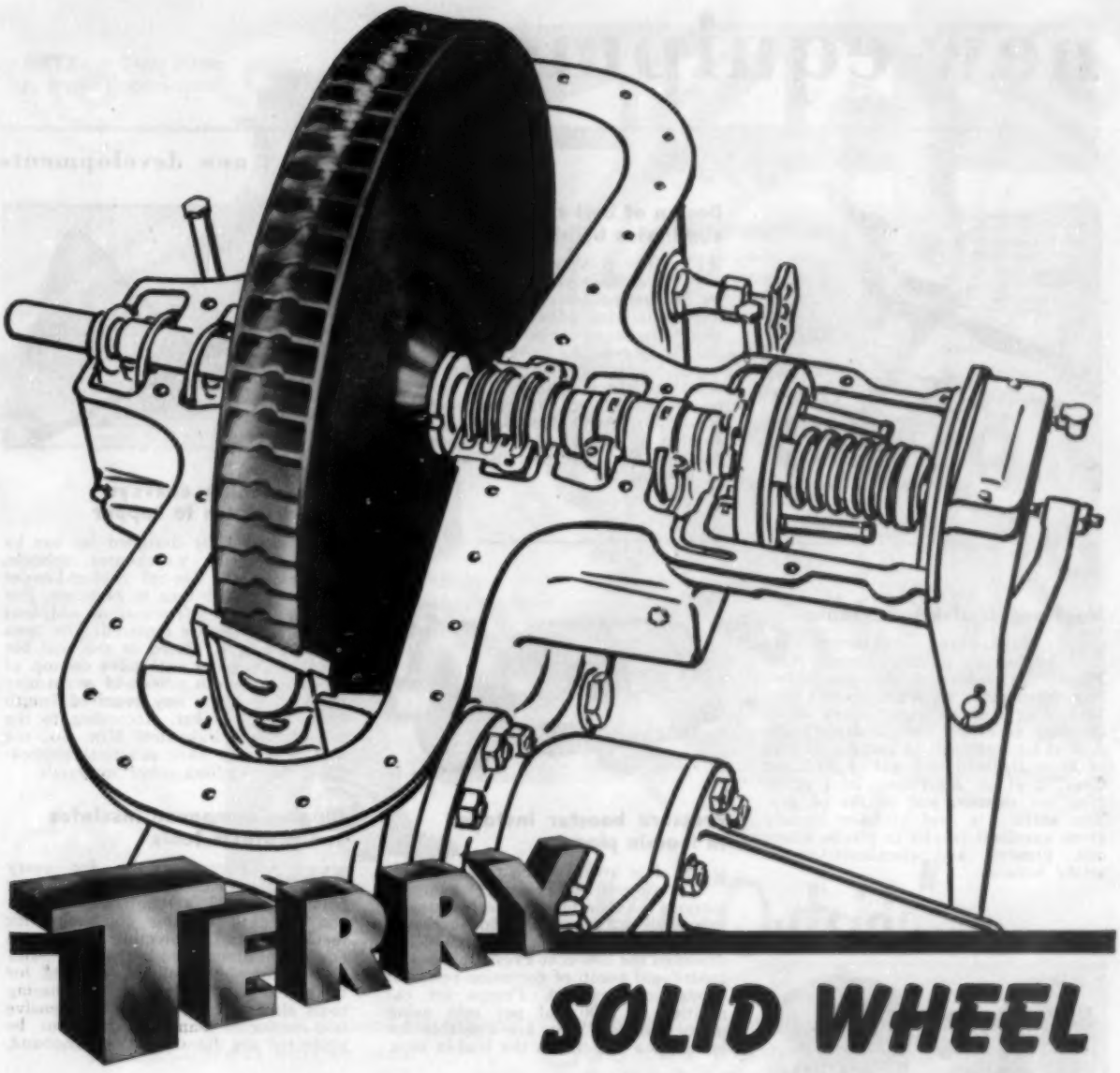
● A robot hand that can function more delicately than a human hand at distances ranging from 12 inches to 1,000 feet, was developed by Minneapolis-Honeywell to operate remotely located controls of reciprocating aircraft or automotive engines during test work. The automatic hand, or "electronic remote positioning system", is said to be 100 times more responsive than hydraulic systems previously used.

Introducing

● Laminol, a new family of chemical finishes for glass fibers used in reinforced plastics, has been announced to the plastics industry during the past several months. Laboratory tests indicate that use of these new chlorosilane finishes in plastics improves their strength, flexibility, and resistance to moisture and temperature.

Novel Reduction Gearing

● A pneumatic angle drive reduction gear with a 212 to 1 ratio can be substituted for the conventional spindle of a corner drill. It develops a superior drive with a spindle speed of 10-20 rpm. Commercial tools with a 100 rpm spindle speed do not perform efficiently at a low speed while using full throttle air pressure and maximum torque.



SOLID WHEEL RUGGEDNESS

is your turbine dividend

The rugged construction and fool-proof design of a Terry solid-wheel turbine can save you money by keeping maintenance costs to a minimum. Usually only taken down for routine inspection, any repairs that must be made are of relatively simple nature, and cost of replacement parts is small.

The rotor of the turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

It is impossible for the blades to foul. They have large clearances and are further protected by the projecting rims of the sides of the wheel. As the side clearances are also very large, end play can do no harm.

The Terry solid-wheel turbine is an extremely reliable piece of equipment—why not write for complete details today? Ask for a copy of Bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

T7-1198

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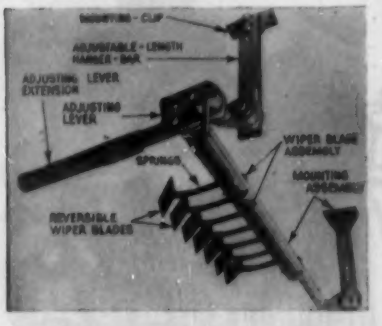
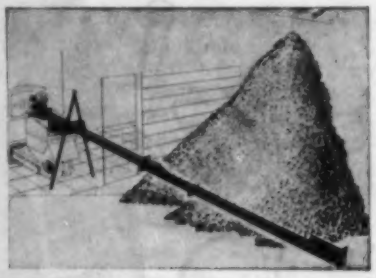
new equipment

. . . new developments



Design of belt cleaner eliminates build-up on arms

K12 The S-A spring type conveyor belt cleaner has been designed by Stephens-Adamson Mfg. Co. to remove material adhering to the belt after discharge, thus increasing belt life by preventing cover wear. Since wiper blades are mounted on spring arms, pressure against the belt can be adjusted for different operating conditions. Arms incorporate a twist so that a vertical edge is exposed to dribble. Complete details are given in bulletin 651.

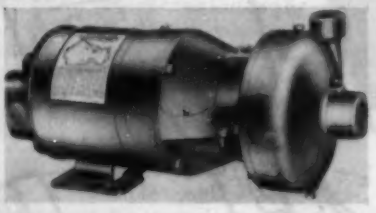


Stoker-loader conveys coal from bin to hopper

K14 Especially designed for use by factories, warehouses, schools, and hotels the bin-fed Stoker-Loader conveys up to 5 tons in 24 hours. For installation, no alterations or additions to the coal bin are required. The open worm screw is placed in the coal bin so that delivered coal piles on top of it. Various length tubes and worm may be combined for any required length from bin to stoker. According to the manufacturer Bakontrol Mfg. Co., the unit may also have practical applications for handling other materials.

NeoFloor trial kit available

K10 Maintenance engineers are now able to test Pennsalt NeoFloor, the industrial skid-proof surface introduced by Pennsylvania Salt Mfg. Co., without guess work as to quantity necessary for a complete job. A trial kit, sufficient to surface an area of 30 sq ft, includes 1 gal of NeoCoat Gray, 1 pt of NeoPrime B, 1 pt of NeoCoat thinner, and 10 lbs of grit. The surface is said to have already given excellent results in plants where oils, greases, and chemicals create safety hazards.

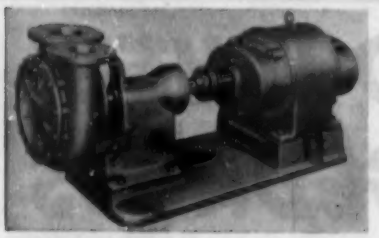


Pressure booster installed in lead-in pipe

K13 For areas where pressures developed by existing pumping stations may be inadequate because of extended water mains and increased water demand, Bell & Gossett Co. has designed the low cost Pressure Booster centrifugal pump of corrosion-resistant bronze construction. Pumps for capacities to 1200 gal per min using motors up to 75 hp are available for installation directly in the lead-in pipe.

Dipping compound insulates and protects tools

K15 A natural choice for every maintenance man's tool kit is compound E-33, a tough, high dielectric strength dipping compound for insulating and protecting tools and equipment announced by Insul-X Sales Co. It completely eliminates need for taping tool handles or purchasing tools already equipped with expensive non-conductor handles. Items to be protected are dipped in the compound,



Centrifugal pumps handle corrosive liquids

K11 Designed especially for handling corrosive liquids and slurries, Fig. 3715 Series centrifugal pumps announced by Goulds Pumps, Inc., are available with the entire fluid end in 316, Gould-A-Loy 20, or 304 stainless steels, all iron, all bronze, bronze fitted, all iron with stainless trim, or all bronze with stainless trim. Maximum liquid temperature limitations for operation of pump has been raised to 350 F with provisions for water cooling of the support head and quenching of the gland.

Controllers available for many applications

K16 Adaptable to a multitude of process applications the new "400" Series Capacitrol electronic controller can be used for such applications as indicating and controlling voltages, current, speed, and similar variables in process industries. Designed by Wheelco Instruments Div. of Barber-Colman Co., the controller is fully gasketed for protection against dust and moisture. Bulletin F 6314 and educational bulletin No. 9 describe various control forms available in the "400" Series.

NOTE—Each new product item has a key number for your convenience in asking for additional, detailed information. Circle this number on Reply Card, pages 34/35 & 98/99.

BETZ• *A Great Name In Water Conditioning*

. . . meet "Mr. Outside"

■ Unusual title for a professional engineer? Perhaps so. Here's what we mean.

Actually, our activities are by no means limited to the regular chemical conditioning and control of boiler and cooling water. Take the Betz Consulting Division, for example.

Here is an entirely separate unit, staffed with chemical, mechanical and sanitary engineers, qualified through years of experience to make unbiased recommendations for the solution of problems involving the *external* conditioning of industrial and municipal water supplies . . . and for treatment and disposal of industrial wastes.

Many, if not most water or waste treatment problems are individual in character. They require study by *specialists* in order to reach a solution that is both operationally and economically sound. Such studies made by the staff of the Betz Consulting Division have saved much effort and productive time for hundreds of plants across industry. How can this important Division of Betz *completely-integrated* water conditioning service assist you?

W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa.

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CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

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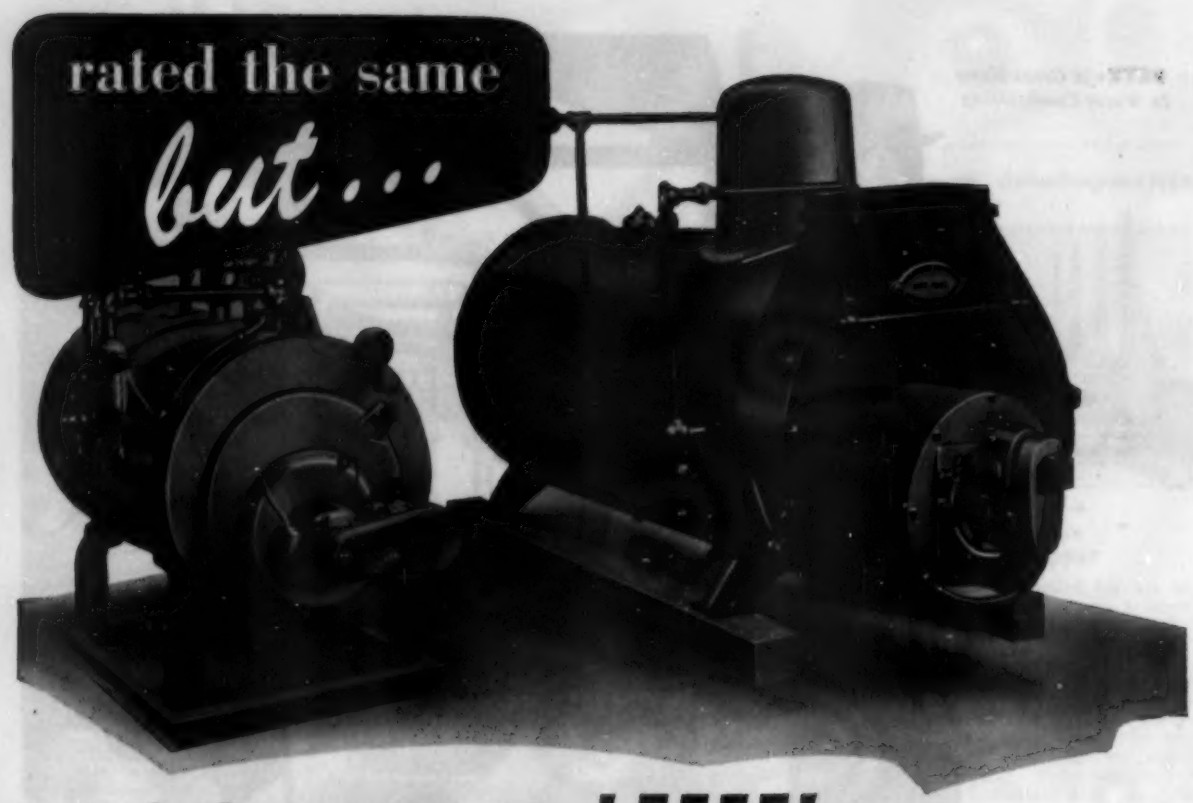


only the bigger, stronger LEFFEL can deliver when you need extra steam

Yes, both boilers are rated at 20 horsepower but have far different performance records. Divergent rating systems make this possible.

The little "package-type" boiler on the left is rated under a system which allows less than three square feet of heating surface per horsepower. It's a "maximum capacity" boiler, designed to produce up to its maximum capacity continuously with little or no reserve capacity. Only 54 square feet of heating surface total!

Not good!

Over nine square feet of heating surface per horsepower are required by the code under which the Leffel is rated. There's a total of 181 square feet of heating surface in this Leffel boiler which is designed to operate at double its rating if necessary.

Excellent planned reserve! Maximum safety for you!

Here's what this rating difference means to you. The Leffel *can* meet any normal demand, even after your business has expanded by 50 percent, for the Leffel boiler can deliver *extra* steam without strain at 50 percent above its normal rating. More startling though, is the fact that even after your Leffel is operating at 50 percent above rating continuously, you *still* have a generous horsepower reserve for peak loads. Leffel boilers can deliver more than *twice* their rated capacities in emergencies.

On the other hand, a maximum rated package boiler or steam generator cannot possibly allow for expansion of your business nor can it meet overloads without dangerous strain. Why chance it?

Any boiler operated continuously at its maximum capacity is prone to frequent breakdowns. That's why many package boiler users must maintain a second boiler as a stand-by source of steam. And breakdowns cost money — in lost production and in repair bills.

Leffel's planned reserve gives longer boiler life, less down time, room for expansion, and greater safety.

If you're looking for a completely dependable source of low cost steam, you'll want to talk with a Leffel representative before you buy. Drop us a line today and we'll arrange an appointment for you.

LOOK AT THESE FIGURES

	LEFFEL BOILER	A "PACKAGE-TYPE" BOILER
Rating	20 HP	20 HP
Length	9'	6' ±
Height	6'8"	4'6" ±
Heating Surface	181 sq. ft.	54 sq ft. ±
Shipping Weight	6500 lbs.	2500 lbs. ±
ACTUAL MAXIMUM CAPACITY	40 HP 1380# per hr.	20 HP 690# per hr. ±

It will pay you—in the long run—to compare carefully and buy wisely.

FOUNDED IN 1862

THE JAMES LEFFEL & CO.

DEPT C, SPRINGFIELD, OHIO, U.S.A.

MORE EFFICIENT STEAM GENERATION FOR 92 YEARS

Circle 506 on Reply Card for more data

COPPUS "BLUE RIBBON" VENTILATORS

FOR WORKERS'

- *Safety*
- *Health*
- *Comfort*
- *Efficiency*

VANO Design "A" VENTILATOR

Vano Design "A" cooling interior of furnace, supplying fresh air through 10 feet of "Ventube" to provide safety and comfort during repair work.

Vano Design "A" delivering fresh air to cable manhole, expelling sewer gas, making entrance safe in a few minutes.

Vano Design "A" Ventilator plus a few accessories feeds large air volume into tank car, driving out fumes, stagnant or hot air for workers' safety and comfort.

Vano Design "A" supplying fresh air in Reactor Room of Synthetic Rubber Plant.

Vano Design "A" Ventilator supplying fresh air to man working in wing compartments, fuselages, etc.

Powered by a ½ hp motor, and equipped with the exclusive Coppus axial-flow propeller-type fan, this general-purpose blower delivers 1500 CFM of fresh air. It supplies ventilation for tanks, tank cars, drums, vats, underground cable manholes, pipe galleries, airplane wing compartments and fuselages, and other confined places. Weighs only 103 lbs. Uses 8"-diameter flexible canvas tubing ("Ventube").

VANO DESIGN "C"

VENTILATOR-EXHAUSTER

Vano Design "C" equipped with 8" discharge tubing removing welding fumes.

Vano Design "C" equipped with two suction lines removing welding fumes for operators' safety.

For withdrawing welding fumes from confined places or directly from the welding rod ...or for expelling fumes or hot air from enclosed vessels. You can get it with 8" suction inlet for 8" non-collapsible tubing ...or with multiple inlet nozzles for 5", 4" or 3" suction hose. The discharge outlet takes 8" "Ventube". Powered by a ½ hp motor, it weighs only 85 lbs.

COPPUS ENGINEERING CORP., 190 PARK AVENUE, WORCESTER 2, MASS.
Please send information on the Blowers that clear the air for Action.

- ☐ in tanks, tank cars, drums, etc.
- ☐ in underground cable manholes.
- ☐ in aeroplane fuselages, wings, etc.
- ☐ on coke ovens.
- ☐ on steam-heated rubber processes.
- ☐ on boiler repair jobs.

COOLING:

- ☐ motors, generators, switchboards.
- ☐ wires and sheets.
- ☐ general man cooling.
- ☐ around cracking stills.
- ☐ exhausting welding fumes.
- ☐ stirring up stagnant air wherever men are working or materiel is drying.

NAME.....

COMPANY.....

ADDRESS.....

CITY.....

(Write here any special ventilating problem you may have.)

COPPUS "BLUE RIBBON" PRODUCTS — *Designed for Your Industry, Engineered for You*

Circle 507 on Reply Card for more data

new equipment

—Starts on page 8

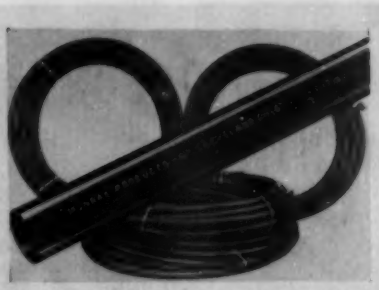
and permitted to drain and dry—a 15 min. operation. Three successive coats an hour apart are recommended for 110 to 220 v exposure.

Portable welding unit designed for aluminum alloys

K17 Designed originally for Harvey Aluminum Company's own field engineers, a compact portable welding unit for light gas welding is being marketed by Burdett Oxygen Co. to fit the needs of building contractors, structural workers, electrical maintenance men, and field welders. Basic unit consists of an 80 cu ft oxygen cylinder, B acetylene cylinder, and accessories consisting of torch and tips, regulators, twin hose, goggles, wrench, and file lighter. The assembly can be used for all commercial aluminum alloys.

Vapor spray degreaser includes motor driven pump

K18 With use of the Super Barrel, the low priced vapor spray degreaser introduced by Baron Industries, parts to be cleaned need never be placed in dirty solvent. Parts are lowered into the vapor zone of the unit and in a matter of seconds automatically cleaned. They emerge warm and dry ready for further processing. The degreaser includes a motor driven pump and spray lance for flushing parts with solvent to facilitate cleaning of extra greasy parts.



New plastic pipe withstands effects of sunlight

K19 Deteriorating effect of sunlight is no longer a problem for users of plastic pipe with the development of a new polyethylene-base flexible plastic pipe by Munray Products, Inc. Flexible and light weight, the pipe contains no anti-oxidants or pigments that would tend to make it toxic. It can be used to convey potable liquids, slurries, and chemicals and is also suitable for use as electrical conduit, especially where it is exposed to sunlight.

TO GET MORE INFORMATION

Circle "key" numbers on Reply Card between pages 34/35 & 98/99. Your requests will be handled promptly.

Underground feeder cable has broad application

K20 Triangle Conduit & Cable Co., Inc. announces Type UF Cable which can be buried directly in the ground as feeders or branch circuits when provided with overcurrent protection, snaked inside masonry block walls, imbedded in plaster or in a shallow chase in masonry block walls when provided with adequate mechanical protection, and used for exposed or concealed wiring in dry, wet, or corrosive locations. It is available with single conductor in sizes #14 through 4, and with two and three conductors in sizes #14 through 10, single or stranded.

Miniature clutch does job of unit twice its size

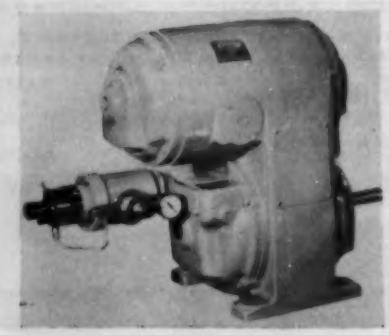
K21 Christensen Clutch Corp. announces the miniature precision Christie Clutch said to do the job of a clutch two or three times its bulk and at low cost. It handles loads up to 2 hp and 25 revolutions per min. It will work on all types of job and power equipment and is said to be easily adapted to any operation using belt or chain drive. Unlike other clutches, this unit requires no end thrust, is rust proof, corrosion resistant, and never needs oiling.

Electrical wiring box is water, oil, and dust tight

K22 Hoffman Engineering Corporation's JIC Electrical Wiring Box, a terminal pull box for wiring, is a sheet metal enclosure that is water, oil, and dust tight. It has a removable panel for mounting chasis, timers, relays, and terminal strips.

Aluminum paint withstands temperatures to 1700 F

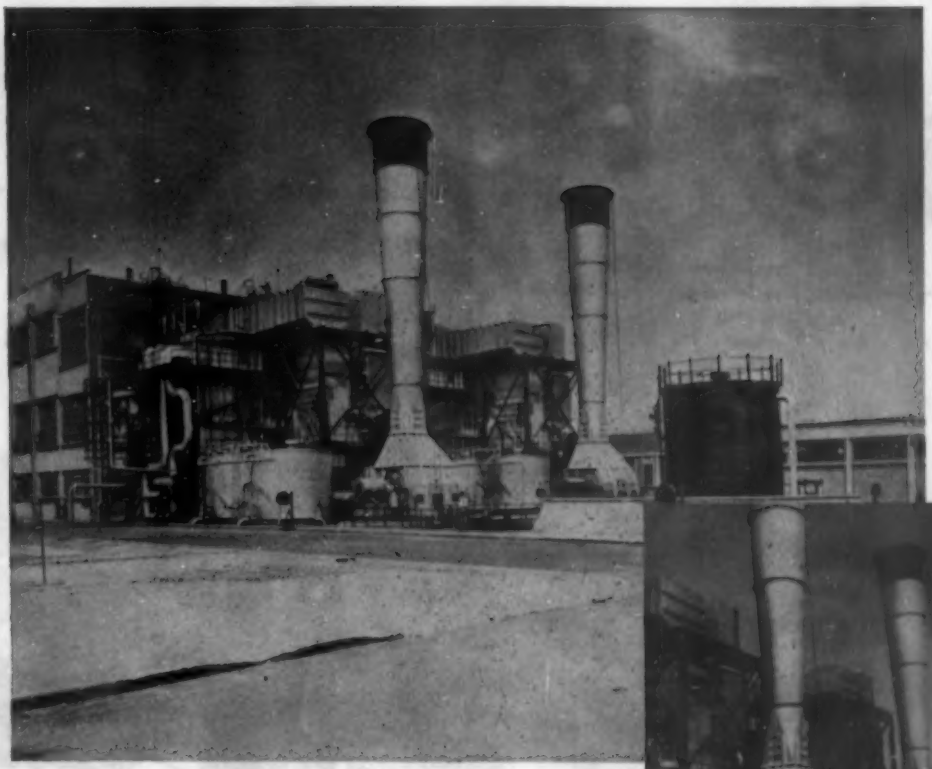
K23 Many types of equipment formerly regarded as unpaintable due to temperature limitations (up to 1700 F) can be painted with

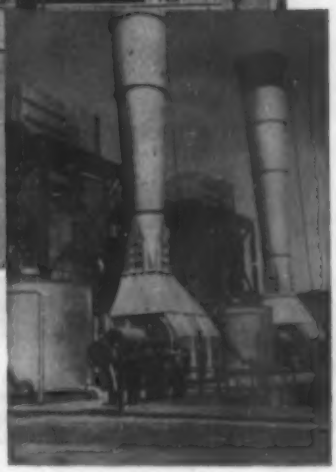


Pneumatic control for variable speed transmission

K24 Sterling Electric Motors, Inc. has designed the Conoflow pneumatic control for application to their Speed-Trol variable speed transmission. This pneumatic control provides an automatically controlled drive for processing operations involving variables such as pressure, temperature, liquid level, proportional flow, and control of rewind. It is available in both manual and automatic types which are sensitive to many types of electrical, mechanical, or pressure signals.

The Lecheria Steam Plant of the Mexican Light & Power Co.





Close-up of the two P-D Fan Stacks at the Lecheria Plant.

pd FAN STACKS

Have a part in the Industrial Progress of Mexico

The Lecheria Steam Plant, operated by the Mexican Light & Power Company—largest electric utility in Mexico—supplies part of the power needed for the industrial growth of the country. Present capacity of the Lecheria Plant is 66,000 kw supplied by two single flow turbines; future expansion plans provide for installation of two additional units of similar or larger capacity.

Aiding the over-all efficiency of the Lecheria Plant are two venturi type P-D Fan Stacks. Each stack incorporates all components (Induced-Draft fan, breeching and stack) required for highly efficient induced draft.

Throughout the world, thousands of P-D Stacks stand as symbols of power—power for the home, power for industry—each a self-contained, well integrated unit designed to complement the modern power plant.

The Thermix Corporation, Project Engineers for Prat-Daniel, offer you a single source of *unit responsibility* . . . and years of specialized experience in solving the most difficult draft problems. Contact them for assistance and ask for data sheets on Prat-Daniel equipment.

Project Engineers

THE THERMIX CORPORATION

GREENWICH, CONN.

(Offices in 38 Principal Cities)

Canadian Affiliates: T. C. CHOWN, LTD., Montreal 25, Quebec

Designers and Manufacturers

PRAT-DANIEL CORPORATION

SOUTH NORWALK, CONN.

POWER DIVISION: Tubular Dust Collectors, Forced Draft Fans, Air Preheaters, Induced Draft Fans, Fan Stacks

Circle 508 on Reply Card for more data

"Yes, I agree... we should stick to coal," said the President.

PLANT ENGINEER: "On the basis of delivered BTU's any other fuel would cost us considerably more than coal."

PURCHASING AGENT: "Coal is the one fuel you can store in large quantities safely and economically. It always gives me a comfortable feeling to know there is at least a month's supply here in the bins."

SUPERINTENDENT: "Since we put in the new stoker and automatic ash removal we haven't had a bit of trouble with dust or smoke; and our boiler room labor cost is down to practically nothing."

SALES MANAGER: "One of our talking points is the uniform finish which comes from an even oven temperature. I hate to think what might happen if we changed to an on-again-off-again heat."

PRESIDENT: "There being no dissenting vote, we will stick to coal."

Bring your fuel problems to C&O

As the world's largest carrier of bituminous coal, the C&O is intimately familiar with every phase of coal use. We have a large staff of experts who will gladly help you to locate the coal best suited to your needs; to help you use it most efficiently; to help get it to you promptly.

Write to:

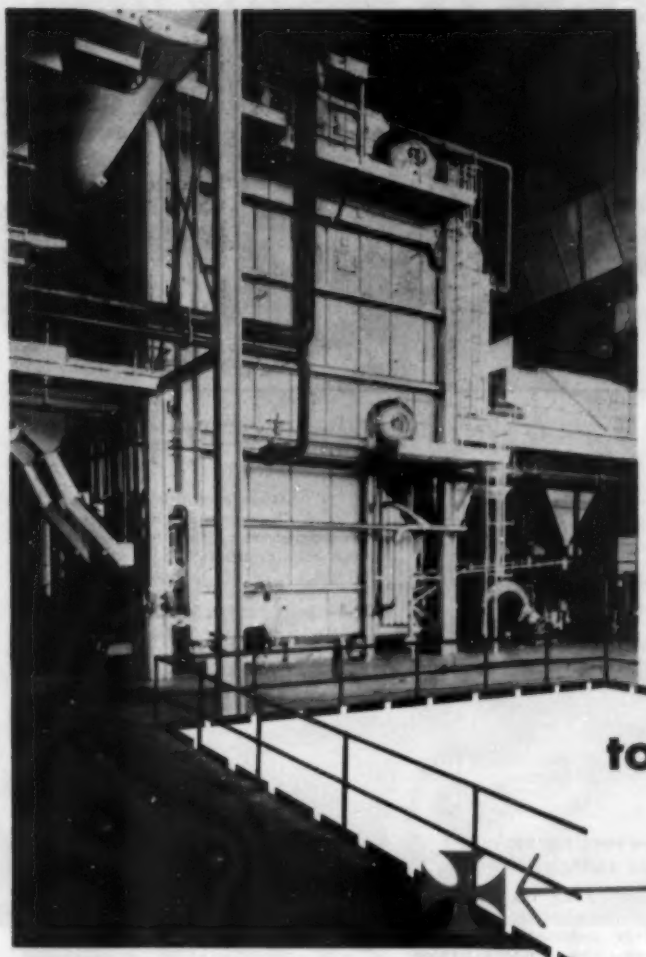
Coal Traffic Department
Chesapeake and Ohio Railway
2110 Terminal Tower
Cleveland 1, Ohio

COAL
FUEL OF THE FUTURE

Chesapeake and Ohio Railway

World's Largest Carrier of Bituminous Coal

Circle 509 on Reply Card for more data



another Detroit RotoGrate Stoker for Manitowoc

Wisconsin

to be installed here

Manitowoc Municipal Power Plant

R. E. Cannard, General Manager and Chief Engineer

In 1950 the Public Utilities Commission of the City of Manitowoc installed their first Detroit RotoGrate Stoker with a 175,000 pound per hour Wickes steam generator.

This installation has been so successful that the Utilities Commission has ordered a second Detroit RotoGrate Stoker to fire another Wickes steam generator of 200,000 pound per hour capacity to be installed adjacent to the first unit. Either Ohio or Indiana coal is used.

Detroit RotoGrate Stoker is an advanced design of spreader stoker with grates that move slowly forward continuously discharging ash at the front. Burns a wide range of Bituminous coals or Lignite without special preparation, also hogged wood or bark and other refuse fuels.

Efficiency and burning rates are high with either steady or rapidly fluctuating loads. Parasite power is low. Combustible content of ash is usually less than 2%.

Get complete data on Detroit RotoGrate Stokers. Recommendations and Bulletins supplied without obligation.

DETROIT SINCE 1898 STOKERS

DETROIT STOKER COMPANY

General Motors Building—Detroit 2, Michigan

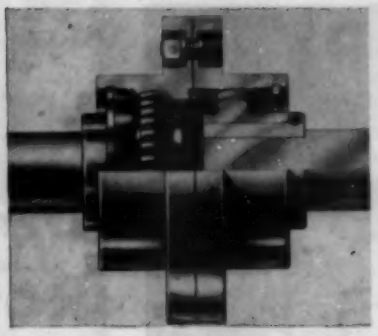
District Offices in Principal Cities • Works at Monroe, Michigan

Circle 510 on Reply Card for more data

new equipment

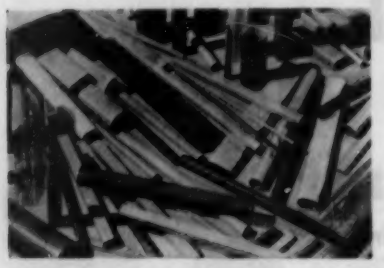
—Starts on page 8

Heat-Rem H-170 extra high heat resistant aluminum paint according to Speco, Inc. The paint drys at normal temperatures without heating and is the newest companion product to the line in the 1000 to 1500 F range.



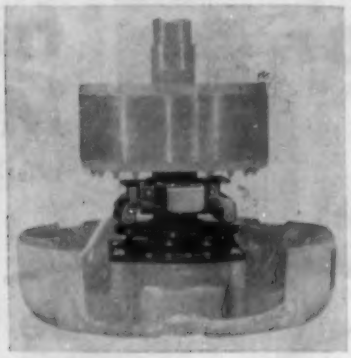
Coupling withstands higher hp and greater misalignment

K29 The Philadelphia Gear Works is now offering the Sphereflex Coupling at competitive price levels with regular couplings. Male teeth of each coupling half are cut on a true spherical arc while the internal teeth are cut with a straight root. Whenever misalignment occurs, the curved tooth maintains a constant area of contact with the internal tooth. Standard Sphereflex Couplings are suitable for angular misalignments up to plus or minus 3½ deg on each coupling half, giving a total of plus or minus 7 deg.



Close tolerances held on coil forms

K25 Any coil form specification in shape, size, length, I.D. or O.D. can now be met to within critical tolerances and supplied in quantity at low unit cost according to the manufacturer, Precision Paper Tube Co. To meet varying electrical and mechanical requirements, the forms may be wound from a wide range of dielectrical materials such as kraft, fish paper, acetate, or combinations.



Automatic reversing motors with integral switch

K27 Reversability of fractional hp single-phase electric motors is made completely automatic with the switch developed by In-Sink-Erator Mfg. Co. The unit is a reversing switch integrated with a starting switch to permit the motor to reverse direction each time it is turned on. It also automatically reverses direction of rotation whenever an unusual overload condition occurs.

TO GET MORE INFORMATION

Circle "key" numbers on Reply Card between pages 34/35 & 98/99. Your requests will be handled promptly.

Alkaline type cleaner for aluminum

K30 Oakite Composition No. 160, an alkaline-type cleaner is said to provide a rapid, uniform, controlled etch on aluminum and to eliminate the troublesome problem of hard sludge build-up on tank surfaces and heating coils. It is readily soluble in water and forms working solutions having unusually long life. Oakite Products, Inc.

Quick-connect hose coupler allows free fluid flow

K31 Char-Lynn Co. has designed the Hydra-Seal Coupler for applications where unrestricted flow of fluid is desired with quick-connect break-away hose coupling. The coupling is available in ⅛ and ¼ in. S.P.T. and will be available in sizes ranging from ½ to 1 in. S.P.T. The free flow is said to eliminate conventional coupler heating, clogging, pressure drop, and power loss.

Pressure controls designed for outdoor use

K26 Wherever positive control of pressure is required, as in chemical plants, the petroleum industry, and utilities, the series DAW weather resistant pressure controls available from Mercoid Corp. will fill the bill. They conform to NEMA specifications 1-A: semi tight, drip tight, weather resistant, and water tight. In 17 operating ranges from 30 in. vacuum to 300-2500 psi, the controls can be supplied with multiple circuit arrangements for various needs.

Weather-proof tape protects stored materials

K28 Polished and finished surfaces can now be protected against scratches and die marks during fabrication, shipment, and storage by the use of "Scotch" brand protective tape No. 344. The weather-resistant tape features a film-like adhesive that sticks immediately upon contact with such materials as stainless steel, glass, most plated metals, and plastics. Minnesota Mining and Manufacturing Co.

Ground detector warns with light and sound

K32 The Brunt Ground Detector and Alarm, a product of Parr Mfg. Corp., is a sentinel to warn of

Permutit Demineralizers deliver highest purity make-up for Illinois Power Company's new 1450 psi steam generator

Hennepin Power Station, Illinois Power Company. Steam Capacity 525,000 lb/hr. Consulting Engineers: Sargent & Lundy

This plant's 75,000 KW turbo-generator must operate continuously at high efficiency.

Tips of turbine blades turn at speed faster than sound. At these speeds, slight amounts of *silica* in make-up water quickly build *dangerous* deposits—destroy turbine efficiency, cause costly shutdowns.

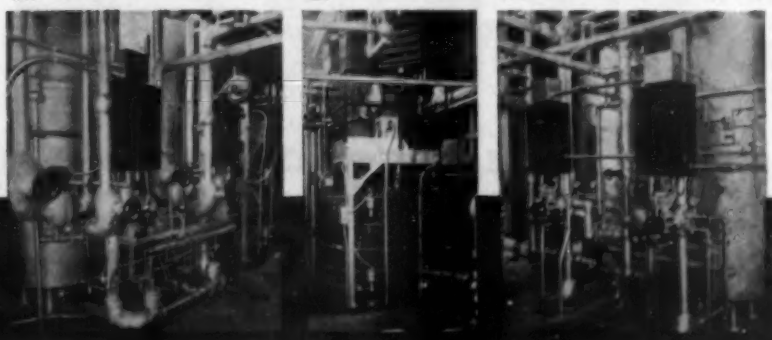
To prevent these troubles, all make-up water is demineralized by the Permutit equipment shown below. Silica is reduced from a harmful 14 ppm to as low as 0.02 ppm—*at low cost!* Total dissolved solids are reduced from 298 to 1.0 ppm!

This keeps 76 miles of boiler tubing free of scale with little or no blowdown. It permits the *high* heat-transfer rates demanded with 1010° F steam at 1450 psi.

Write to us for aid in solving your water problem. Permutit makes the world's most complete line of ion exchangers and water conditioning equipment. We can help save you time and money with the one combination that best suits your needs.

The Permutit Company, Dept. IP-10, 330 West 42nd Street, New York 36, N. Y., or Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

A. B. C.



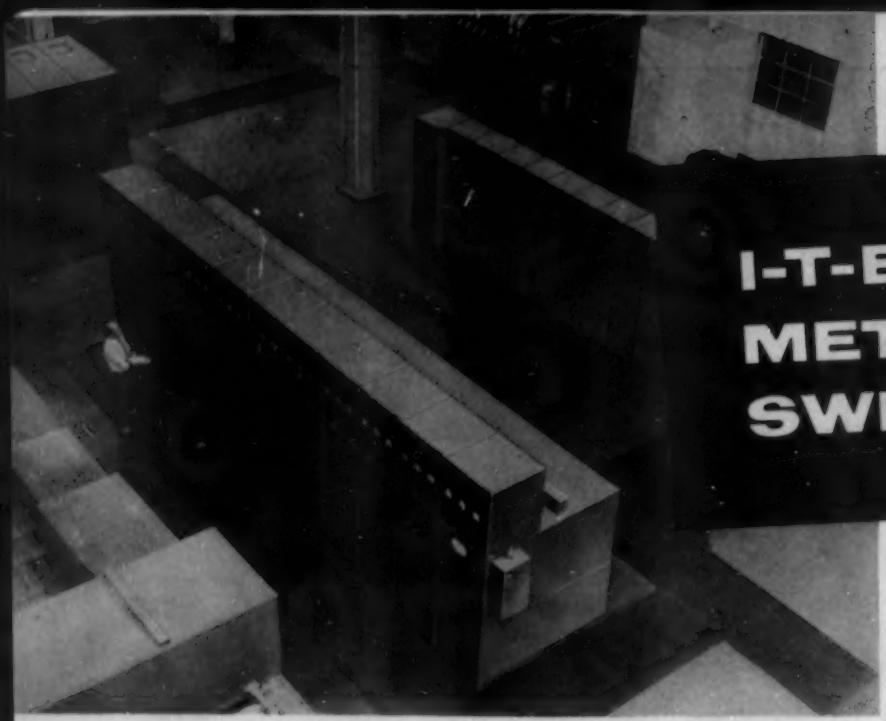
A. *Automatic Permutit Q units remove metallic cations from well water supply.*

B. *Permutit Degasifier removes CO_2, reducing operating cost.*

C. *Automatic Permutit S units remove remaining troublesome mineral impurities by anion exchange.*

Ion Exchange and Water Conditioning Headquarters for Over 40 Years.

PERMUTIT®



I-T-E METAL-CLAD SWITCHGEAR

Your metal-clad switchgear is a *vital* purchase. That's why you should take advantage of the many advanced engineering features of I-T-E quality equipment. They add up to a sound investment which pays *extra* dividends for years and *years* in maximum electrical protection, control, and service continuity.

I-T-E air circuit breakers are the heart of your switchgear. With an I-T-E HV breaker you get *positive arc interruption* —the ultimate in air breaker performance. In just one instant of its lifetime, this rugged device can repay its cost many times over. In addition to superior breakers, the modern I-T-E switchboard incorporates the highest quality components and accessories.

I-T-E metal-clad switchgear is completely factory-assembled and -tested *before* it arrives at the installation site. Tight construction schedules are met by dimensionally accurate assemblies which need only be brought to their location and connected according to plan.

I-T-E extra-service benefits include application engineering aid in (1) selection and application of equipment, (2) preparation of specifications, and (3) coordination of all job requirements.

RATINGS

2400, 4160, 7200, 13,800 volts a-c
50,000 through 500,000 KVA interrupting
600 through 2000 amperes continuous

For details, contact the I-T-E field office nearest you. Look in your classified directory under "Electric Equipment," or write for Bulletin 7004B.

THE SYMBOL OF QUALITY SWITCHGEAR

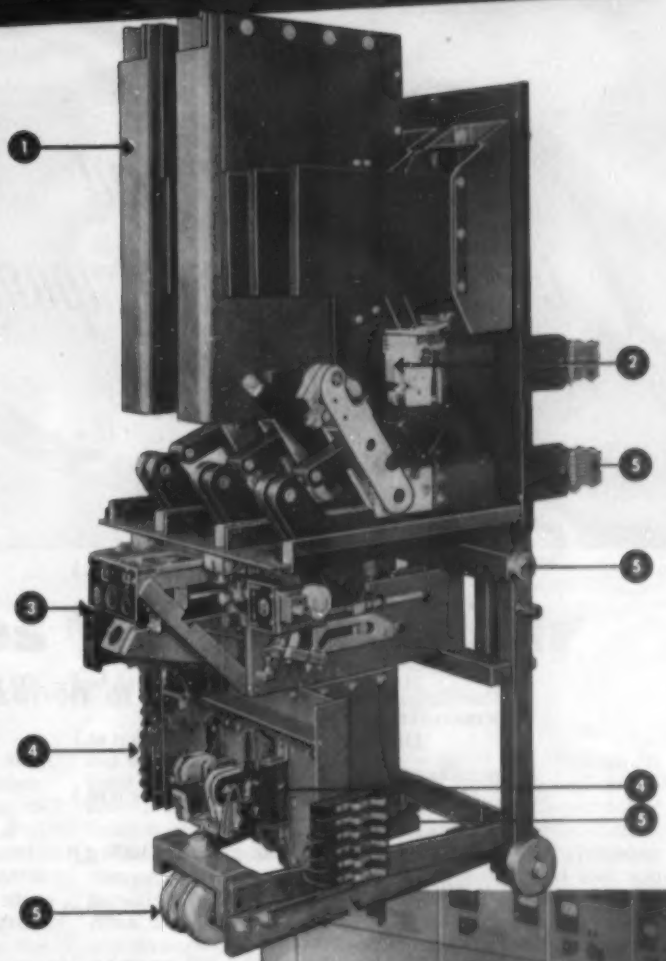
I-T-E CIRCUIT BREAKER COMPANY

19th AND HAMILTON STS., PHILADELPHIA 30, PA.

METAL-CLAD SWITCHGEAR

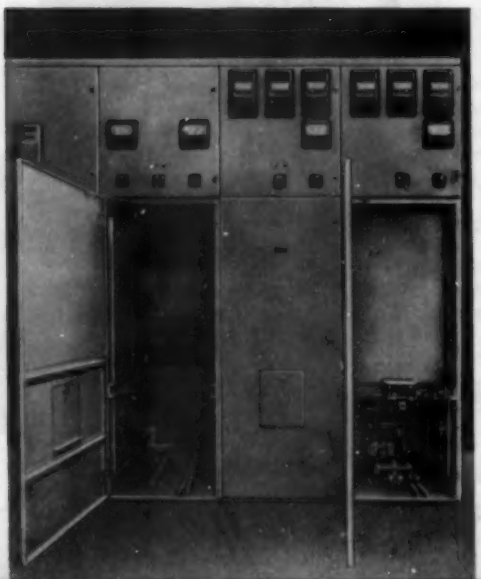
Circle 527 on Reply Card for more data

engineered for • Protection • Safety • Accessibility



CHECK THIS ADVANCED I-T-E ENGINEERING:

1. **Positive arc interruption** is provided by carefully designed arc chutes, contacts, and blowout irons.
2. **Sturdy main and arcing contacts** are designed to minimize wear and deterioration due to arcing.
3. **Simplified testing** is achieved by centralizing electrical test button, manual trip button, breaker positioning device, and emergency breaker closing handle.
4. **Easy inspection and maintenance** is afforded by readily accessible secondary control relays, rectifiers, auxiliary switches, and separable contacts.
5. **Truck-type horizontal drawout** is facilitated by precision-made guide wheels, bar, and self-aligning contacts.



ACCESSIBLE COMPARTMENT DESIGN features wide-opening doors. Withdrawal of breaker closes grounded, steel shutters to protect personnel. Metal partitions completely segregate compartments. Instruments and relays are fully isolated from breakers, safe from jar and vibration—protecting against damage and false operation.

TO TEST BREAKER quickly and safely operator works through small auxiliary door—from *outside* compartment. Other safety features include complete interlocking of breaker operation, segregation of circuit wiring, proper venting of arc gases, and utilization of correct insulation materials.

Demineralization and Silica Removal

CATEXER® ANEXER® PLANTS

provide the low silica, low solids boiler feed makeup water so essential to the operation of high pressure boiler and turbine operation in the plants listed below.

Good Equipment is known by the Company it keeps....

- PUBLIC SERVICE CO. OF NORTHERN ILL.
  Waukegan, Ill. (3 bed – 250 g.p.m.)
- WISCONSIN POWER AND LIGHT CO.
  Sheboygan, Wis. (2 bed – 60 g.p.m.)
- WESTERN ELECTRIC CO.
  Hawthorne Sta., Chicago, Ill. (2 bed – 200 g.p.m.)
- INTERSTATE POWER CO.
  Dubuque, Iowa (2 bed – 30 g.p.m.)
- INTERNATIONAL PAPER CO.
  Natchez, Miss. (2 bed – 900 g.p.m.)
- INTERNATIONAL PAPER CO.
  Panama City, Fla. (2 bed – 1200 g.p.m.)
- CALIFORNIA ELECTRIC CO.
  High Grove, Calif. (2 bed – 40 g.p.m.)
- NATIONAL PETROCHEMICALS CORP.
  Ficklin, Ill. (2 bed – 400 g.p.m.)
- WISCONSIN POWER AND LIGHT CO.
  North Beloit, Wis. (2 bed & mixed bed – 40 g.p.m.)

for useful information
on sodium, hydrogen or anion exchangers...
write for INFILCO Bulletin 1960-Y.

INFILCO INC. | *Tucson, Arizona*

Plants in Chicago and Joliet, Illinois

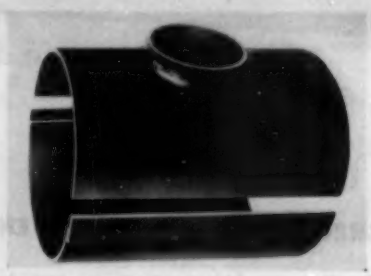
Field offices in 33 principal cities in the U. S., Canada and Mexico

Circle 512 on Reply Card for more data

new equipment

—Starts on page 8

accidental grounds as soon as they occur on power lines. The device indicates the phase of the ground, flashes a red warning light, and actuates a bell or horn. Connections to the ground alarm are made at the main distribution panel and the instrument itself can be installed in any convenient spot.



Hot taps made safer with encirclement saddle

K33 Tube-Turn's Full Encirclement Saddle provides the 360 deg reinforcement so desirable when dealing with high pressures and large diameter pipe and taps. It meets requirements for reinforcement of welded branch connections as developed by Section 8 of The Code for Pressure Piping. It is designed for use with either high yield strength thin wall pipe, Grade B 35,000 or 42,000 yield strength pipe, and also for heavy wall cylinders employed for suction and discharge headers, bottles and pulsation dampners in compressor stations. Division National Cylinder Gas Company.

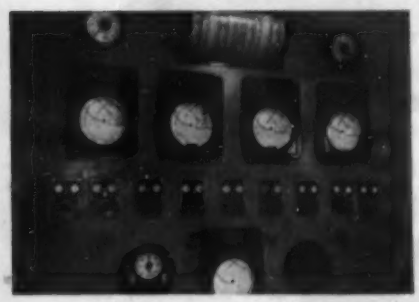
Complete operation handled through control box on truck

K34 Barrett-Cravens Co. has developed the PO-40 Hi-Lift electric truck which changes stock selection from a two-man to a one-man task. Raising or lowering the platform

DuPont saves $7,000 a year

with just partial modernization of coal burning equipment

The boiler plant at DuPont's Barksdale Works was operating inefficiently, due to an old forced draft system and unwieldy combustion control. DuPont engineers decided to modernize these operations, estimating that the cost would be amortized quickly through the increase in efficiency. An up-to-date draft fan and automatic combustion control system were installed. Today savings of $7,000 annually have been realized—a gross return on the investment of 140%! Not only has the new equipment paid for itself in one year, but it has produced the additional advantages of reduced ash-pit losses, lowered maintenance costs, increased steaming capacity.



Control Board at Barksdale Works. Steam generating equipment consists of four 15,000 lb./hr. 150 psi stoker-fired boilers.

Thousands Saved

More and more plants are saving thousands of dollars yearly burning coal the modern way. The reasons are obvious. In most industrial areas, coal is the cheapest fuel available. Not only do you actually get more BTUs per dollar from coal, but the efficiency of modern combustion equipment extracts even more benefit from coal's inherent energy. What's more, today's automatic coal and ash handling methods mean minimum labor costs. Coal is *clean*, too. It travels in dust-tight chutes; ashes are piped out through pneumatic tubes; there is no smoke problem. And between our vast coal reserves and highly mechanized coal production, you can count on coal remaining plentiful and its price remaining stable.

Investigate Fuel Costs

If you're planning to modernize your old plant or build a new one—or if you are just interested in cutting fuel costs—find out how coal burned the modern way compares to other fuels for *your* plant. Talk to a consulting engineer or your nearest coal distributor. Their advice may save you thousands of dollars every year.

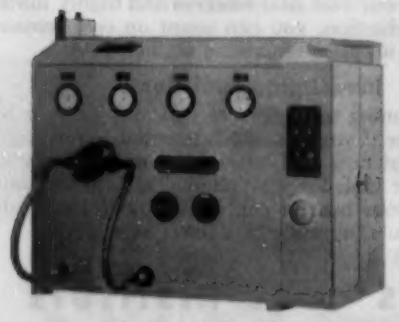
BITUMINOUS COAL INSTITUTE

A department of National Coal Association
Southern Building, Washington 5, D. C.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address above.

Circle 513 on Reply Card for more Data

fully automatic, or semi-automatic



As an extra assurance of *immediate* satisfactory operation, each Peabody PK-54 is thoroughly fire tested and adjusted at our Factory *before shipment.*

Fully approved, the PK-54 is the most compact and complete burner in the industry with forced-draft fan, combustion and all safety controls built into the unit. Firing gas, oil or both, automatically or semi-automatically, for boilers up to 42,000 lbs. of steam per hour, the PK-54 represents a notable advance in combustion engineering. For complete details write for Bulletin 430.

PEABODY ENGINEERING CORPORATION

918 580 FIFTH AVENUE, NEW YORK 36, N. Y.

Circle 514 on Reply Card for more data

new equipment

—Starts on page 8

is controlled by push buttons enclosed in the operating panel. One handle controls the four operations of horizontal travel.

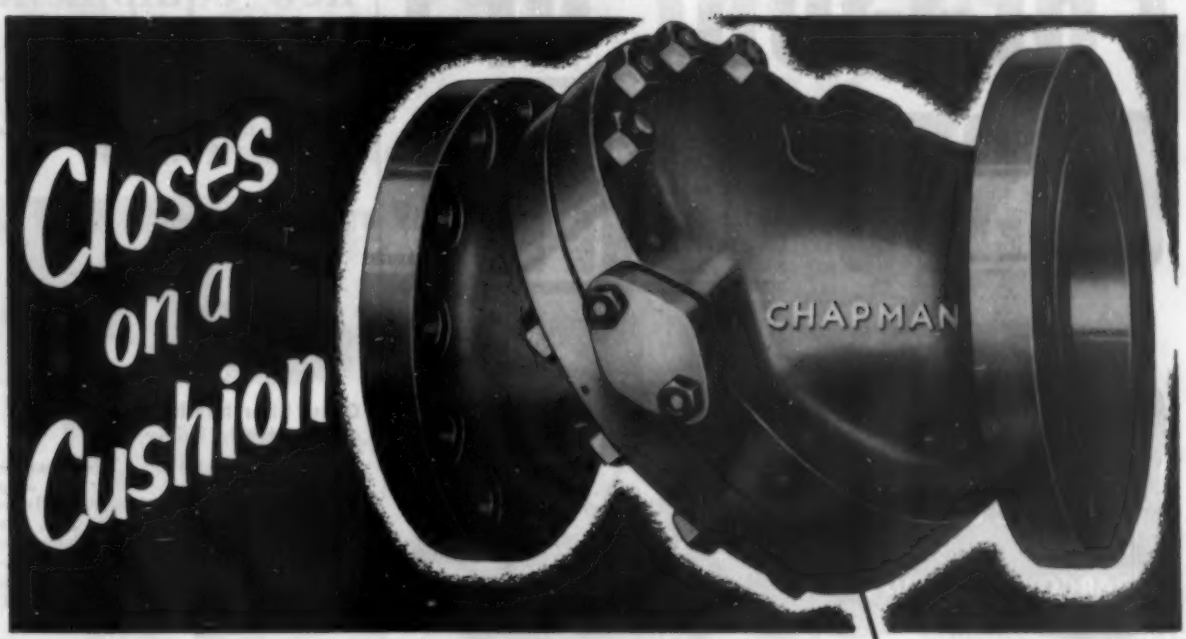
Lubrication system designed for small machine elements

K35 Small and delicate mechanisms formerly at the mercy of "oil-can" methods of lubrication can be served by the L Special, a tiny compact lubricating system especially designed for machines with minimum lubrication needs. The unit includes all the elements of a complete lubrication system—reservoir, filter, pump, and Meter-Units, but is smaller than a pack of cigarettes. The reservoir holds 20 cc and the pump can be adjusted to discharge a total of 0.6, 0.45, or 0.3 cc each time the plunger is pulled. The unit has been used successfully on cloth cutters, coil winders, and rotary index tables according to the manufacturer Bijur Lubricating Co. Literature is available.

Diffusers prevent shifting of exchange resin bed

K36 For efficient operation of cation and anion exchangers and to prevent windrowing and shifting of exchange resin bed, the Permutit Co. has perfected cylindrical inlet diffusers, as shown in the illustration. For hydrogen exchangers these devices are fabricated from an inert plastic; for the sodium cation exchangers the diffusers are made of perforated metal.

Chapman's Tilting Disc Check Valve

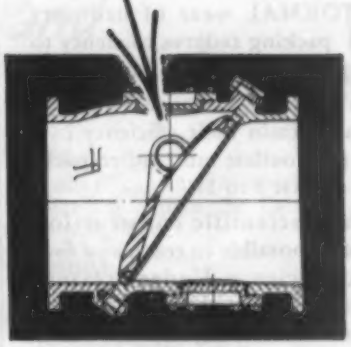


...for low cost, slam-free operation

Balanced pressures *cushion* the movement of the disc in Chapman's Tilting Disc Check Valve. The valve closes quickly but quietly, in all but unusual piping arrangements. There's no slamming to damage pipe-line joints or the valve itself. And *drop-tight* closure eliminates sliding wear on the disc and seat.

In the open position, the "airfoil" designed disc rides firmly against stops, without swinging or fluttering. That's why the hardened extra-large hinge pins give extremely long wear. And the absence of turbulence is one reason why head loss through Chapman's Tilting Disc Check Valve is lower than through any other type of check valve.

Low head loss, increased wear resistance and freedom from destructive slamming make Chapman's Tilting Disc Check Valves unbeatable for almost every installation. Write for Catalog No. 30 today.



Here's why
CHAPMAN Tilting Disc Check Valves
***Keep Quiet* All Their Lives**

This specially designed "airfoil" disc balances perfectly in open position . . . then drops easily to closed position (cushioned by the flow). No jarring or slamming, in usual pipe-layouts. Write for bulletin.

THE CHAPMAN VALVE MANUFACTURING COMPANY
INDIAN ORCHARD, MASSACHUSETTS

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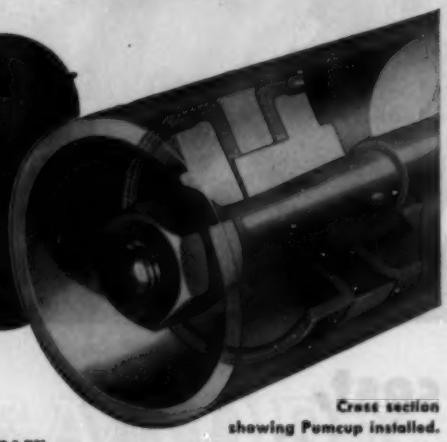
PRESSURE UP! COSTS DOWN!

Slippage Reduced
in PUMPS
AIR CYLINDERS and
HYDRAULIC CYLINDERS
with
DARCOVA PUMCUPS



Cross section showing Pumcup installed.

NORMAL wear of ordinary packing reduces efficiency to a tremendous degree.

In contrast, Darcova Pumcups actually retain their efficiency . . . and they outlast most other packings at least 3 to 1!

Their scientific construction makes it possible to reach *and hold* peak efficiency. Under pressure Pumcups hug the cylinder walls to provide a uniform seal and exert full pressure where it is needed. This means reduced slippage, lower power costs and far less maintenance.

Write for helpful data-and-proof bulletins: No. 4502 on Pumcups for air and hydraulic mechanisms; No. 4401 on Pumcups for reciprocating pumps.

Cost-minded engineers in many industries have standardized on Pumcups to solve their packing problems. The list of successful applications includes the following installations:

Die casting machines
Forming and drawing presses
Straightening presses
Pipe bending machines
Briquetting machines
Pusher mechanisms
Door control devices
Lifting and dumping devices
Spraying equipment
Proportioning pump regulators
Recoil cylinders
Air booster pumps
Grease guns
Automatic bottling and filling machines
Extrusion presses
Steering mechanisms

DARCOVA
THE ORIGINAL COMPOSITION CUP

DARLING VALVE & MANUFACTURING CO.
WILLIAMSPORT 9, PA.

PUMCUPS

Circle 516 on Reply Card for more data

new equipment

—Starts on page 8

They are tapped and threaded for a standard pipe connector.

Glass fiber handle on electrode holder

K37 The molded glass fiber handle featured on the 14 oz, 300 amp Type B-20 Caddy Cub Electrode Holder, made by Erico Products, Inc., has high tensile strength, is impervious to moisture, arc radiation, and mechanical abuse. The holder handles continuous duty 1/16 to 3/16 in. electrodes, and ¼ in. electrodes intermittently.

Tachometers give instant rpm reading

K38 Instantaneous-reading type Smiths tachometer, available from Clarence J. Marx Co., has an accuracy within ±0.5 percent and a torque demand at 5000 rpm of 0.075 ounce-inches. It will measure rotional speeds to 50,000 rpm or surface speeds to 25,000 ft per min.

Hand tool available for compression-applied connectors

K39 Thomas & Betts Co. is introducing the UT-5 hand tool for installing the company's new line of compression-applied distribution and service connectors. Range of conductors accommodated includes #8 stranded to #2 stranded and solid copper, #6

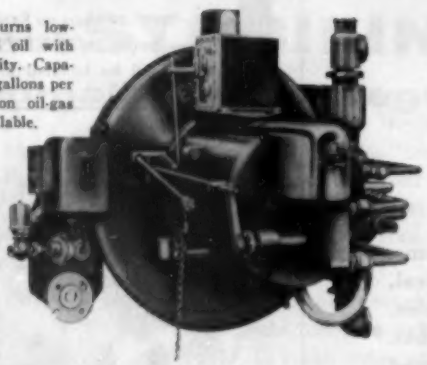
Is inefficient firing stealing dollars from your pocket?

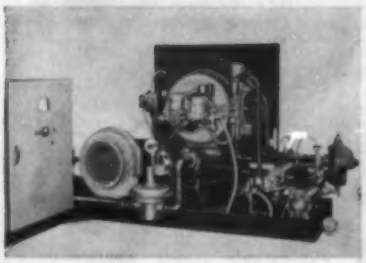
install a

PETRO INDUSTRIAL OIL BURNER

and save 3 ways

Rotary type. Burns low-cost heavy fuel oil with complete reliability. Capacities up to 200 gallons per hour. Combination oil-gas models also available.





Petro "Packaged Unit" (for oil or gas or both). A complete combustion system in which all elements are correctly balanced and integrated. Simply bolt to boiler front and make service connections and it's ready to go.

Send for free catalog today . . .

1. Fire low-cost oils

Petro fires the heavy fuel oils (Nos. 5 and 6) which average 8% richer in heat value than the light burner oils, and cost less per gallon.

2. Save fuel and labor

They efficiently fire heavy oils with complete dependability, following load changes automatically. This makes fuel go farther and saves labor.

3. Low maintenance cost

They are sturdily built and thoroughly reliable. This means low maintenance costs.

There's a Petro burner to fit almost every boiler, in sizes from 11 to 200 gallons per hour.

Heating contractors everywhere recommend and install Petro oil equipment. For illustrated catalog write Petro, 3028 West 106th Street, Cleveland 11, Ohio.

In Canada, write 2231 Bloor Street West, Toronto, Ontario.

Residential Oil and Gas Burners, Oil and Gas Furnaces and Boilers
Industrial and Commercial Oil, Gas and Oil-Gas Combination Burners

PETRO

T.M. REG. U.S. PAT. OFF.

OVER 50 YEARS OF LEADERSHIP IN AUTOMATIC HEATING AND POWER EQUIPMENT

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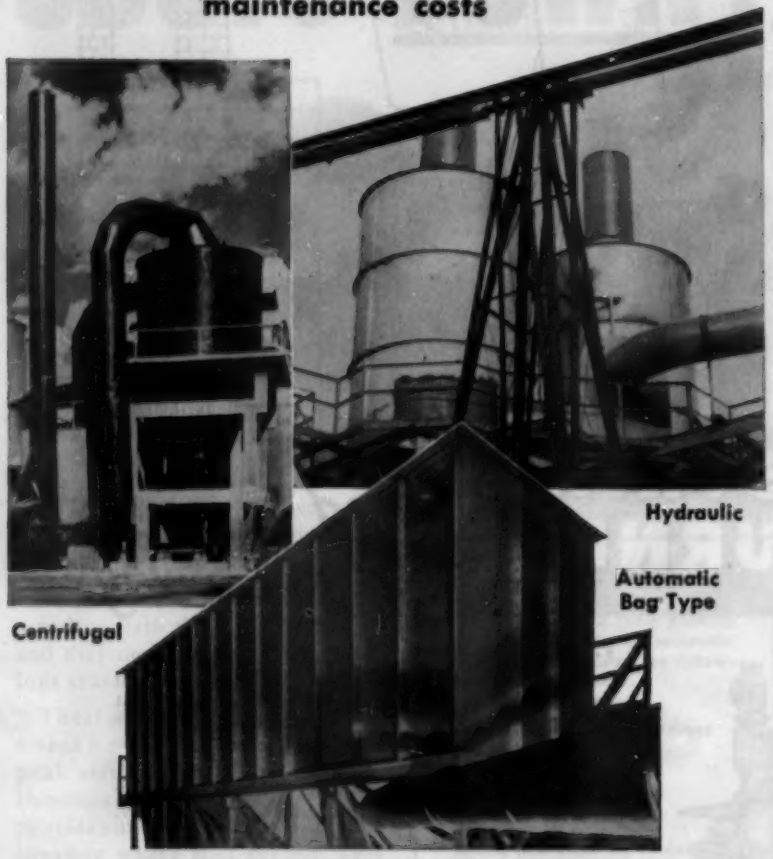
Norblo

Dust and Fume Collection Systems

make outstanding records for high recovery with low operating and maintenance costs



Centrifugal

Hydraulic

Automatic Bag Type

These three important types of Norblo collecting systems, frequently used in certain combinations, bring you economical, dependable control as required in a wide range of industries. "Guaranteed Efficiency" is not an empty phrase at Norblo. We stand back of every installation that's used for the purpose and at the capacity for which we designed it. All component parts are made by Norblo, under controlled specifications.

For more than 40 years Norblo has engineered and supplied installations of every size in the rock products, smelting, chemical, metal working, milling and processing fields. It pays you to get the facts about Norblo Dust and Fume Collecting Systems. Give us a description of your problems.

The Northern Blower Company

Engineered Dust Collection Systems for All Industries

6422 Barberton Ave. OLympic 1-1300 Cleveland 2, Ohio

Circle 518 on Reply Card for more data

new equipment

—Starts on page 8

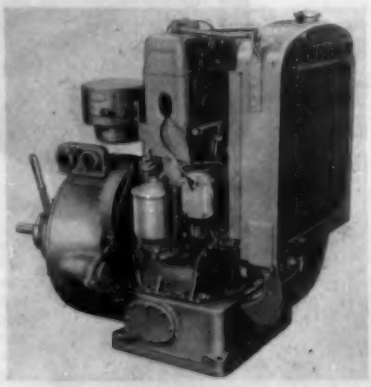
solid to #2/0 stranded aluminum, and #6 to #1/0 aluminum cable, steel reinforced.

Fans meet modern industrial requirements

K40 In sizes 111 through 133, Type XL Fans are particularly well adapted to diversified air and material handling applications because of their in-the-field flexibility. In sizes 137 through 160 high efficiency and adaptability of application are featured. These fans will handle air or gases to 1000 F, volumes to 130,000 cfm, pressures to 18 in. static. Clarage Fan Co.

TO REQUEST ADDITIONAL DATA

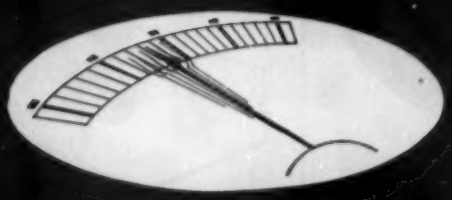
Circle "key" numbers on Reply Card between pages 34/35 & 98/99. Your requests will be handled promptly.



Gas engine designed for small power application

K41 For small power application where natural gas is available, Nordberg Manufacturing Co. is introducing the Power Chief single cylinder spark-fired gas engine rated at from

If Rejects X are a production problem you may have V.V.T.*



*Varying Voltage Trouble

STABILINE Type EM4115

ask your electrical engineer about STABILINE automatic voltage regulators

When an automatic machine or process goes "out of kilter" put a voltmeter in the line and watch it. Varying loads in your plant may be the cause of serious and frequently overlooked trouble where timers, solenoids and electronic gear are concerned. The same goes for inspection department troubles, too.

You may be hounding some foreman when actually your Electrical Engineer can spot the trouble and cure it in no time at all. If he says V.V.T. is the cause and recommends a STABILINE Automatic Voltage Regulator you know *those* troubles are under control.

Write for more facts and see Superior Electric's Mobile Display when it is in your area.

THE SUPERIOR ELECTRIC COMPANY

2110 CLARKE AVENUE, BRISTOL, CONN.

Manufacturers of: Powerstat Variable Transformers • Stabiline Automatic Voltage Regulators • Voltbox A-C Power Supplies • Powerstat Light Dimming Equipment • Varicell D-C Power Supplies • Superior 5-Way Binding Posts

STABILINE Type EM

feature:

1. Available in 115, 230 and 460 volt ratings for single and three phase duty in capacities up to 100 KVA.
2. Zero waveform distortion.
3. Correction speed from .075 to .32 seconds per volt.
4. High efficiency comparable to fixed-ratio transformers.

THE SUPERIOR ELECTRIC COMPANY
2110 Clarke Avenue, Bristol, Conn.

Please send STABILINE Bulletin S351.

Name.....

Position.....

Company Name.....

Company Address.....

City.....Zone.....State.....

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Standardize on AJAX SPIRAL WOUND GASKETS for all steam plant services

for LOWER pressures

Type "H" Ajax Spiral Wound Gaskets with integral wire centering guide answer the demand for a low-priced self centering ring gasket. Permit the use of the smallest, least-expensive gasket for maximum sealing effect. For pressures up to 600 psi.

for HIGHER pressures

Type "S-R" Ajax Spiral Wound Gaskets with solid metal reinforcing ring which locates gasket inside bolt circle, prevents lateral expansion under pressure and acts as a compression gauge for maximum gasket efficiency. For pressures up to 1500 psi.

for BOILERS and ACCESSORIES

Ajax Spiral Wound Gaskets are offered in all sizes and shapes for manholes, hand holes, tube caps, etc., for all standard makes and models of boilers, water walls, economizers and other boiler accessories.

For Safer Seals at lower bolt loads—Use AJAX Spiral Wound

UNITED STATES GASKET COMPANY
CAMDEN 1 • NEW JERSEY
FABRICATORS OF duPont TEFLON, Kellogg KEL-F AND OTHER PLASTICS
Representatives in Principal Cities Throughout the World

CALL YOUR INDUSTRIAL DISTRIBUTOR . . . or write for Catalog No. AG-953.

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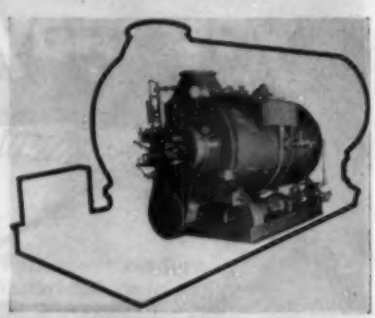
new equipment

—Starts on page 8

9 to 18 maximum bhp within an operating speed range of 800 to 1800 rpm. It has a 4½ in. bore and 5¼ in. stroke and is an extra heavy duty, vertical, spark ignition four-cycle engine.

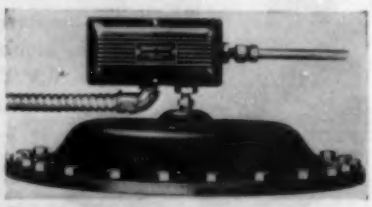


Size of 250 hp boiler reduced by 80 percent

K42 One-fifth the size of a standard boiler, as shown in the illustration, the 250 hp Cyclotherm, utilizing Cyclonic Combustion, is 6 ft wide, 6 ft 8 in. high, and only 9 ft 5 in. long. Designed by Cyclotherm Div. of U. S. Radiator Corp., for 15 to 200 psi, it delivers a maximum guarantee of 7500 lb of steam per hr with a normal operating capacity of 6250 lb per hr.

Midget solenoid valves available in many models

K43 Midget solenoid valves, introduced by General Controls Co., are available in many models for a variety of applications in the handling of all types of gases and liquids. They have soft seat, tight shut-off construction. In stainless steel types all internal parts are steel to assure long life in handling of corrosives.



Power relay eliminates transmission lags

K44 The Autronic Type P2R Power Relay, being introduced by the Swartwout Co., eliminates transmission lags common to all-pneumatic systems, without use of electric motors, boosters, or slide wires. It is designed to operate with the Swartwout Autronic Control System. The unit can be used either reverse- or direct-acting.

save from the start

replace your castings with flame cut parts

SHAPES CUT FROM PLATE — UP TO 16" THICK

If your casting has two flat sides and a perpendicular edge in almost any shape, it can be cut out of steel plate by FOSTER. Flame cut parts are better than castings in some applications because they are lighter in weight, easier to machine, have greater strength, and cost less money. Shown above is a group of National Cylinder Gas flame cutting machines in operation. By using such modern equipment, FOSTER is able to mass produce shape cut parts at reasonable prices. Sometimes a casting can be replaced by a weldment. Two or more parts cut from steel plate and welded together may often present a considerable saving over a similar casting. Any reasonable shape from 1" square to 8 square feet can be cut by FOSTER — to your exact specifications.

For structural and steel plate assemblies — shearing, braking, machining, rolling, flame cutting, welding to your exact requirements — make Foster your first call!

THE FOSTER COMPANY • Stevensville, Michigan

THE foster COMPANY

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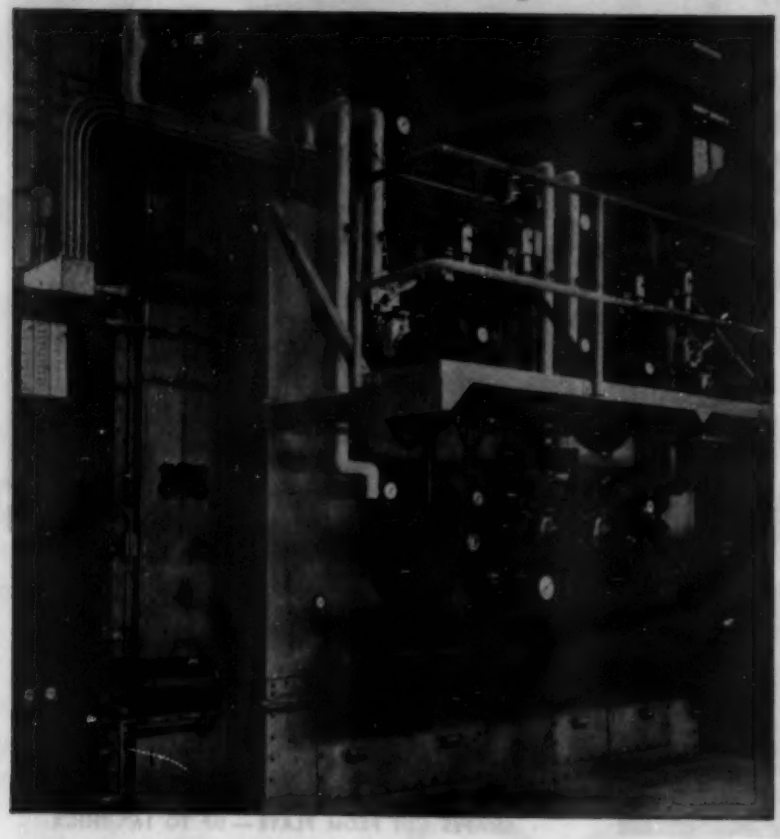
ENCO GAS-OIL BURNERS for LOWER Fuel Costs



The Enco gas-oil burners in this boiler will burn oil or gas—or both. The change-over is simple and is made according to the availability or cost of these fuels. Thus the plant can avoid a shut-down when one fuel cannot be obtained, or can switch from one fuel to the other according to the relative prices or the cost per btu. Combustion is uniform with either fuel or both, even though steam demands swing sharply—another fuel-saving, money-saving feature. Other Enco burners offer similar economies for boilers of practically all sizes and types.

We invite inquiries on all burner problems — including those involving a wide range of capacities with a demand for complete atomization. We have had 35 years of experience in this field.

THE ENGINEER COMPANY

75 WEST STREET, NEW YORK 6, N. Y.

IN CANADA: ROCK UTILITIES LTD., 80 JEAN TALON ST. W., MONTREAL, P. Q.

Circle 522 on Reply Card for more data

letters

. . . from readers

Cool Man, Cool

Sir:

I have read the article on a centralized cooling system in your August, 1954 issue. ... I do not understand how you can make the statement that "Finally, the system makes it possible to consistently maintain a uniform coolant temperature." ... the heat generated in cutting metal plus the temperature in the air at the machines could very easily build up in the coolant and raise the temperature.

... you might be interested in looking at an entirely different centralized coolant setup that we installed during the War. This system was capable of delivering 3095 gal per min to 112 grinding machines.

Coolant was returned to the central system through a setup of troughs and trenches. The dirty coolant containing steel chips and abrasive material from the grinding wheels discharged into a tank (which) had about a dozen 10 in. diameter pipe outlets at the bottom. Each pipe had a butterfly shut-off valve . . . a cloth bag over the end of each of these pipes permitted the coolant to flow out through the bags which rested on a floor grating. The bags filtered out the coarse material from the coolant . . . , the coolant going through the bag and the floor grating into a tank from which it was pumped through filters made by Honen Crane Company. After passing through these filters . . . , the coolant went to Niagara heat exchangers (which) were able to maintain the temperature of the coolant within 2 F. We were able to operate this setup without shut down for allowing the coolant to cool down even when the ambient temperature exceeded 100 F.

C. L. Williams
Kelsey-Hayes Wheel Company
Detroit 32, Michigan

—Mr. D. S. Stoneman of the Warner Swasey Co. replied as follows: "The coolant temperature in this system is uniformly maintained because of the large volume of coolant totaling 4200 gal and the long covered floor channels through which the spent coolant must flow back to the filtering tanks.

"It is true, of course, that after the system has been shut down for

REFRACTORY CONCRETE

is easy to make with a Castable Refractory

Just add water to a packaged castable, mix, and you're ready to place refractory concrete. Castable refractories supply you with the right combination of selected aggregates and Lumnite* calcium-aluminate cement carefully proportioned to meet the heat resistance and insulation requirements of many jobs.

Chances are this convenient way to make Refractory Concrete can speed work and cut costs on your next refractory job. Why not keep a few bags on hand—you'll have "two strikes" on your next emergency repair! Castables are made and distributed by manufacturers of refractories.

Refractory concrete made with castables is the *adaptable* refractory—can be easily placed in any size or shape . . . resists severe thermal shock and spalling. It can be poured, troweled or "shot" on by cement gun, and it's ready for service in 24 hours or less.

For additional information, write Lumnite Division, Universal Atlas Cement Company, (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N. Y. or contact any of the offices shown below.

OFFICES: Albany • Birmingham • Boston • Chicago • Dayton
Kansas City • Minneapolis • New York • Philadelphia • Pittsburgh
St. Louis • Waco

*"*LUMNITE" is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

IP-L-84

ATLAS® **LUMNITE for INDUSTRIAL CONCRETES**

REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

A UNIVERSAL ATLAS PRODUCT

UNITED STATES STEEL HOUR—Televised alternate weeks—See your newspaper for time and station.

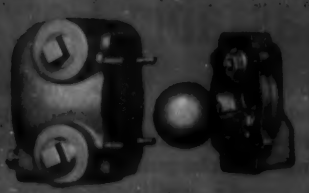
Circle 523 on Reply Card for more data

NEW HOFFMAN
FLOAT and
FLOAT and THERMOSTATIC
TRAPS

FEATURING:

1. Integral thermostatic air by-pass consisting of thermal element, seat, and cage—factory set and sealed.
2. Valve lever and seat assembly constructed of brass stampings. Spherical steel copper clad float.
3. Stainless steel valve pin and valve seat—valve pin adjustable for positive seating.
4. All working parts mounted on the cover for easy accessibility—no pipe connections to break.

LOW MAINTENANCE COST



Float and Thermostatic Traps with cover construction so designed that all working parts of the trap are readily accessible. Once installed there is no necessity for the breaking of any pipe connection as all cleaning and repairing can be made by removing the cover of the trap.

FOR PIPE COILS

FOR UNIT HEATER

MECHANICAL FLOAT TRAP WITH EXTERNAL BY-PASS

Again Hoffman provides industry with an improved product, refined to *function more effectively and economically in removing condensate.*

Hoffman engineers thus anticipate industrial steam heating trends that demand less maintenance and operating costs.

The new 50 Series Float and Thermostatic Trap has an integral thermostatic air by-pass consisting of thermal element, seat, and cage, factory set and sealed assuring dependable service and easy maintenance.

The same fine Hoffman quality and precision workmanship prevails in these traps as in the other Hoffman heating specialties. The valve lever and seat assembly is constructed of durable brass stampings. The spherical float is copper clad steel. The valve pin, adjustable for positive seating, and the valve seat are made of stainless steel. Sizes are available from ¾" to 2"—pressure requirements of ½ lb. to 125 lb.

If you are planning to install low, medium or high pressure Float or Float and Thermostatic Traps, it will pay you to ask for Hoffman's new illustrated catalog sheet, available upon request.

HOFFMAN SPECIALTY MFG. CORP., 1001 York Street, Indianapolis 7, Indiana

Makers of Valves, Traps, Hot Water Heating Systems, Vacuum and Condensate Pumps

Circle 524 on Reply Card for more data

letters

—Starts on page 30

a period of time, there will be a certain degree of coolant temperature rise when it is again started.

". . . the coolant dissipates any heat which it has acquired during the grinding processes into the floor channels and during the filtering process. By the time the coolant is completely filtered and returned to the tanks to be mixed with the unused coolant, its temperature for all practical purposes has returned to its normal or original value."

Dip Versus Pressure

Sir:

The August issue of INDUSTRY AND POWER contains an article entitled "A Maintenance Headache Is Licked." This article makes note of the fact that dip treatment of lumber is probably one of the simplest, cheapest and most effective means of applying wood preservative. The dip method is definitely the simplest and cheapest method of applying a wood preservative, but it is just as definitely not the most effective. There are innumerable publications which discuss the dip treatment of wood, pointing out the treatment will probably pay for itself but that the most economical treatment on an annual cost basis is pressure treament. This has been the experience of the railroads and utility companies, who are the larger users of treated material.

Pressure treatment increases the service life many many times that of untreated lumber when it is subject to attack by decay or termites, as compared to the approximate 30 percent increase realized from dip treatment stated in the article.

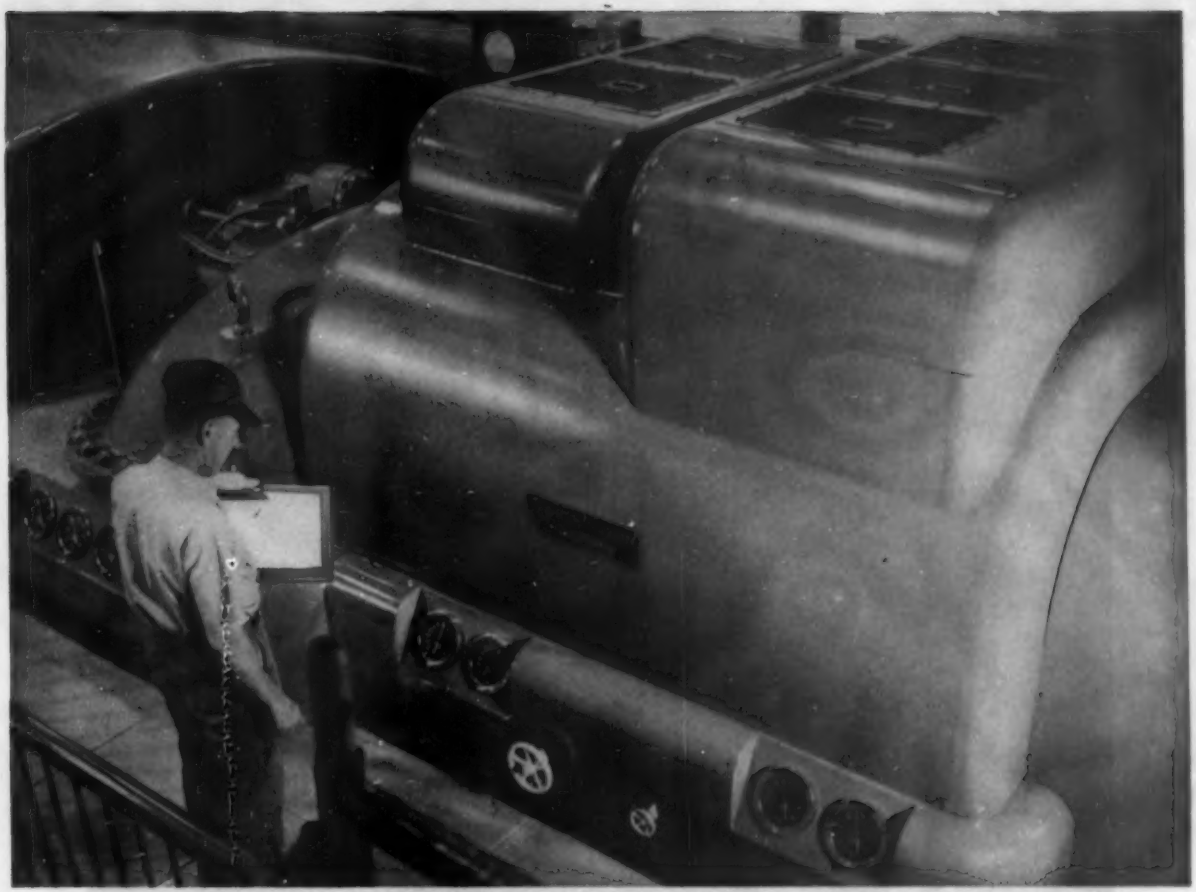
D. L. Davies
Manager Technical Dept.
Wood Preserving Div.
Koppers Company, Inc.
Orrville, Ohio

Aid in Work

Gentlemen:

Please send me your publication INDUSTRY AND POWER. I find this magazine a great aid in my work.

Albert Migdal
Migdal & Layne Engineers
Detroit, Michigan



MODERN DESIGN IN TURBINE-GENERATORS. This streamlined Worthington turbine-generator unit at the University of North Carolina is capable of developing 2500 kw over and above the 10,000 kw normally produced. In addition, sufficient steam is automatically extracted to heat the University buildings.

Look how turbine-generators have changed!

Remember the bulky, complicated turbine-generators of only a few years ago?

Compare them with this sleek, powerful Worthington 10,000-kw unit installed at the University of North Carolina last year. Everything about this turbine-generator is modern and up-to-date.

Look at the streamlined heavy steel lagging which covers the turbine, generators and exciter. Note the recessed dials, set at a thirty degree angle so they may be read from standing height with ease. And the dials don't project into the room, where they might be damaged.

In addition to getting the most modern unit of its kind, the University of North Carolina benefitted by the undivided responsibility that goes with every Worthington turbine-generator. Each is designed, assembled, and tested as a complete unit *before* shipment.

Find out how Worthington turbine-generator sets pay off in longer, more economical power generation service. Sizes range up to 11,500 kw. Get in touch with your nearest Worthington district office for more information. Or write to Worthington Corporation, Steam Turbine Division, Section T.4.2, Wellsville, New York. T.4.2

WORTHINGTON

STEAM TURBINES

Single- and Multi-Stage Turbines • Turbine-Generators • Deaerators • Boiler Feed Pumps • Surface Condensers

A GREAT TEAM IN STEAM

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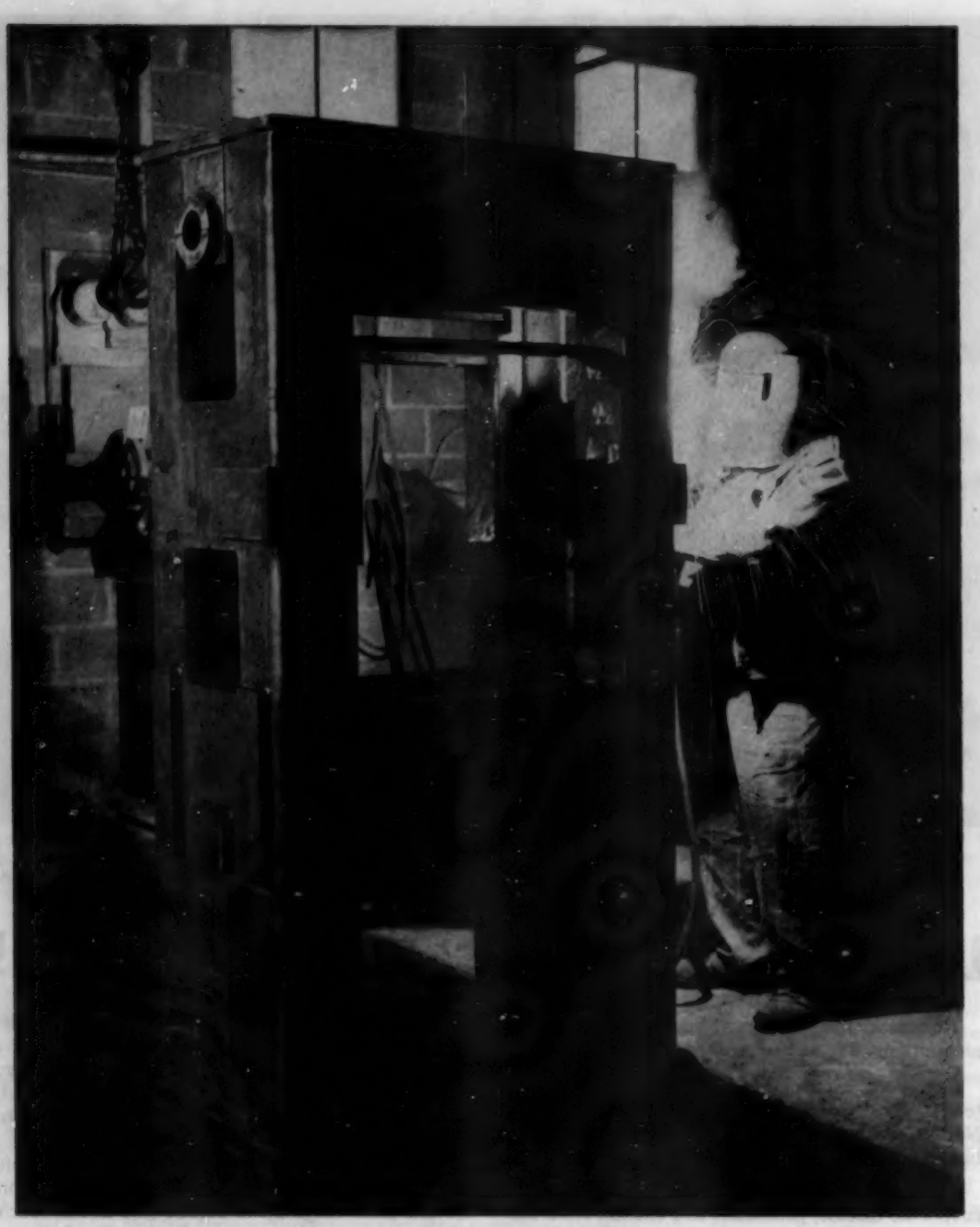

BETTER PRODUCTS AT LOWER COSTS- *by fabrication*

Photo above is all-steel punch press frame, Tho a third lighter than expensive castings it replaced, greater strength and rigidity of welded construction enable punch press to operate 50% faster.

Besides basic saving of material, plus values are reduced freight and handling costs, easier machining qualities. And future design changes can be made at nominal cost.

Because steel can be formed or cut into almost any size, shape or thickness, doubtless some of your own castings can be replaced by fabricated steel, at really worth-while savings.

Send us a print or a sketch of your product. Or if you wish our engineer will call on you. No obligation in either case.

THE FOSTER COMPANY, Saint Joseph, Mich.

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R/M V-BELTS

If you use equipment powered by multiple V-belt drives, you can step up production efficiency — and lower costs — with R/M V-Belts. R/M Super-Power V-Belts and Condor V-Belts are the smoothest running V-Belts made because every part of their construction is precision-balanced. Straight sidewalls on these V-belts provide more grip, less slip, trouble-free performance. They last longer and do more work, too. On some drives you can count on 40% greater horsepower capacity with R/M Super-Power V-Belts as compared to regular V-belts . . . or do an equal job with fewer belts!

Whatever your particular V-belt needs, either R/M Super-Power or Condor is your assurance of longer belt life, improved performance and greater drive economy at your plant . . . "More Use per Dollar". Consult an R/M representative. Ask him about R/M Hose, Transmission, Conveyor Belts and other industrial rubber products for every use . . . in every industry.

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings
Asbestos Textiles • Packings • Engineered Plastic, and Sintered Metal Products • Bowling Balls

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new bulletins

. . . catalogs from leading manufacturers

200—Filming Amine Protection

"Film Forming Corrosion Inhibitors Also Aid Heat Transfer," four-page technical paper No. 129 contains references to protection afforded by filming amines and attendant reduction in maintenance costs secured through protection against corrosion. W. H. & L. D. Betz.

201—Cushioned Valve

The Flowtrol Valve, designed to replace troublesome globe, angle, plug, or gate valves that require frequent manual opening and closing is described in seven-page technical bulletin W8-A. Construction of the two-way and three-way valves is shown by means of line drawings. Golden-Anderson Valve Specialty Co.

202—Heavy-Oil Burners

Belt driven horizontal rotary type heavy-oil burners, available in forty combinations of control, ignition, shut-off, and type are described in eight-page booklet 178-H. The newly-developed equalizing valve which is said to improve automatic starts on No. 6 oil is shown in schematic illustrations and phantom view. Preferred Utilities Corp.

203—How to Cure Water Hammer

This engineering data book covers the complete subject of cure and prevention of water hammer at the design level. A fold-out sizing procedure section enables any mechanical engineer to size the Shok-stop required to prevent any water hammer problem before the building is erected. Wade Mfg. Co.

204—Controller Catalog

Nine controller types from basic "building block" parts are pictured in eleven-page catalog 3-10. An exploded view of the P-4 Controller is presented along with wiring diagrams and a phantom view explaining operation and construction details. Fischer & Porter Co.

205—Concrete Storage Bins

Concrete stave storage bins are discussed in 20-page technical brochure. It contains tables of cubic foot weights of flowable materials, capacities, description of wall construction, test data, and other relevant engineering data with many photographs and line drawings. The Neff & Fry Co.

206—Machinery Protection

How to protect your machinery by using the Kushion-Torq shaft couplings is explained in four-page bulletin 30. Dampening of radial and torsional vibration, compensation for misalignment, and protection against impact are discussed. Brown Engineering Co.

207—Fusible Service Equipment

For a complete listing of the Noark line of fusible service equipment—30 through 6000 amp—you will need this "Service Equipment" bulletin. It describes exclusive features of the line and includes diagrams showing typical wiring and knock-out locations for each catalog number. Federal Pacific Electric Co.

208—Spinning Gas Technique

Operation and advantages of the Continental Automatic Boiler's "spinning gas technique," a method of obtaining maximum heat transfer with a simplified design, is explained in four-page booklet BE-4. A cut-away view of one of these packaged boilers shows method of injecting the air and other features. Boiler Engineering & Supply Co., Inc.

209—Check Your Steam Costs

"Have You Checked Your Steam Costs Lately?" This 18-page handbook is a non-technical presentation of vital interest to every one considering merits of replacing existing boiler equipment or considering purchase of new boiler equipment for a new operation. Orr & Sembower, Inc.

210—Versatile Swivel Fittings

Illustrated with many sectional drawings and clearly showing the various types of packing for steam, hot water, oil, L-P gas, and chemicals, catalog FS-107 covers the Emsco HP and HT small size high pressure and high temperature ball bearing swivel fittings. Emsco Mfg. Co.

211—Open-Tank Water Heating

The new V-groove Steam Diffuser for introducing steam directly into the water for open-tank heating is described in this one-page data sheet. Capacities in gallons per minute at 100 lbs steam pressure are listed in table form. A cut-away view explains operation of the unit. O'Brien Steam Specialty Co., Inc.

212—Engine Preheaters

With cold weather not far distant, you will want the information contained in this bulletin on the KIM hotstart, an electric preheater for diesel and gas engines. Typical installations are shown and specifications listed for various sizes and types of engines. KIM Hotstart Mfg. Co.

213—Medium Range Boilers

Information on operation and specifications of Type 1, Type 2, and Type 3 packaged boilers built to meet steam requirements in the medium pressure range, from 4100 to 30,000 lbs of steam per hr, is included in nine-page booklet WT-7. Engineering data and photos are included. Wm. Bros Boiler & Mfg. Co.

214—Efficient Power Transmission

Power transmission equipment to give you the production advantages you want are described in four-page bulletin. Each unit is briefly but informatively described and accompanied by an illustration. Included are Wedg-built Drives, Shaft-King Speed-Reduction Drives, Adjustable-Speed Sheaves, and many other types. American Pulley Co.

215—Roof Maintenance Kit

How the package system of supplying essential roof maintenance materials and tools can help you in resurfacing or repairing roofs is explained in four-page folder. Described are the G-C Package for resurfacing and the G-P Package for repairing flashings, gutters, cracked or blistered felts, and other roof weak spots. Pictures show methods of application and advantages of this company's products. Lexsuco, Inc.

216—Tips for Valve Users

"Technical Tips," four-page bulletin 542 describes and illustrates data gathered by this company's laboratories on valve material installation and usage. Many of the tests described were the direct result of inquiries or requests from customers for solutions to particular problems. Edward Valves, Inc., subs. of Rockwell Mfg. Co.

217—Boosters and Accumulators

Complete engineering data on boosters and accumulators is contained in eight-page catalog B-54. The booklet will serve as a guide for the application of air-hydraulic units. It covers in detail applications of the Petch Air Low-Pressure Hydraulic and High Pressure Hydraulic 4-tie-rod cylinders. Petch Mfg. Co.

218—Protective Coatings

In easy-to-read outline form, this catalog contains important facts about protective coatings and their many industrial applications. A list of this company's Magic-Vulc coatings and their uses is included. Magic Chemical Co.

219—Tools to Specification

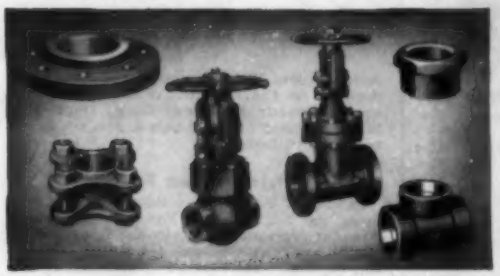
This eight-page catalog of quality tools gives specifications for in-stock items plus descriptions and ordering information for custom-made tools. Included are hand and drive punches, die-makers tubes, eyelet setting tools and dies, and foot machines among others. Eyelet Tool Co., Inc.

Flange and Coupling Selector

This revised edition of the popular Flange and Coupling Selector is in the same easy-to-read slide rule form and provides all the information contained in the earlier selector plus new and useful data.

NOTE — Each new bulletin item has a key number for your convenience in asking for a free, personal copy. Circle key numbers on Reply Card between pages 34/35 & 98/99.

Designed for today's *Tough* service demands



DROP FORGED VALVES AND FITTINGS FOR TOUGHNESS AND TROUBLE-FREE SERVICE

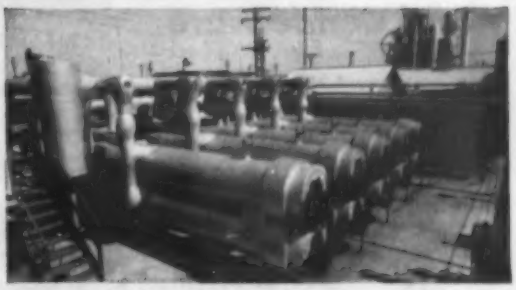
Drop forged from carbon and alloy steels, Vogt valves, fittings and flanges will safely handle liquids and gases at high pressures and high temperatures in power plants, chemical plants, petroleum refineries, etc. The complete line includes flanged, screwed and socket weld end globe, gate and check valves—ells, tees, and crosses—couplings—bushings—plugs—unions—flanges and flange unions—and welding heads.

MODERN STEAM GENERATORS

Vogt steam generators are designed to give maximum rating in a minimum of space, with high efficiency and low maintenance expense. Bent tube types and straight tube, forged steel sectional header types to burn solid, liquid or gaseous fuels meet every power, process or heating requirement.

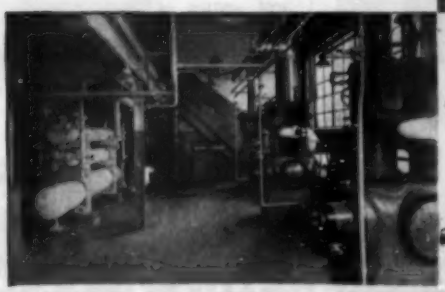
PROCESS EQUIPMENT FOR EVERY SERVICE

Vogt constructs process equipment in wide variety to all Codes. Stills and towers, oil chillers, crystallizers, heat exchangers, molding machines, etc., serve in the manufacture of oils, greases, 100 octane gasoline, synthetic rubber, chemicals and related products around the world.



SPECIAL MATERIALS COMBAT CORROSION AND PRODUCT CONTAMINATION

Our modern shops produce a wide variety of equipment from special metals and alloys to fight corrosion and product discoloration or contamination. Fabrication procedures insure that corrosion resistant properties of welds will match that of the materials used to construct the equipment.



MORE REFRIGERATION TONNAGE AT LESS COST

More than 70 years of engineering and manufacturing experience is incorporated in Vogt refrigerating and ice making equipment. Absorption Systems, Compression Systems, and Tube-Ice Machines in a wide range of capacities serve industrial and processing plants, and institutions, here and abroad.

Vogt

PRODUCTS

FOR REFINERIES, CHEMICAL PLANTS POWER PLANTS AND PROCESS INDUSTRIES

HENRY VOGT MACHINE CO.
LOUISVILLE 10, KY.

BRANCH OFFICES: New York, Philadelphia, Chicago, Cleveland St. Louis, Dallas, Charleston, W. Va.

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Reliability

DESIGNS THAT REPRESENT 50 YEARS TRAP BUILDING EXPERIENCE

"airxpel"

STEAM TRAPS

Remove Both Air and Condensate

This equipment offers design advantages that represent long experience in building steam saving devices for industry.

Orifices of Wright-Austin traps can be interchanged without disassembling the trap. Connections are the straight-through type. Both of these features contribute to speed and ease of installation.

Wright-Austin traps are available for lines ½" to 3", for pressures up to 600 P.S.I.G. and with capacities up to 65,025 pounds of water per hour.

For complete information on traps and other accessories that you can stock to advantage and depend on for efficiency that means low cost, write, today, for:

Trap Catalog #600
Separator Catalog #500
Boiler Trim Catalog #700

"CUB" TYPE
½" to 1½"
to 250 PSIG

"MASTER" TYPE
½" to 2"
to 300 PSIG

"Y" STRAINERS
2" to 8" (flanged)
½" to 3" (threaded)

FORGED STEEL
½" to 1¼"
to 600 PSIG

WA Standard since 1894 STEAM USERS

WRIGHT-AUSTIN
COMPANY
3245 WIGHT STREET • DETROIT 7, MICH.

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new bulletins

—Starts on page 36

A convenient Pipe Standard Table is incorporated on the selector. Please send requests directly to Nooter Corp., Dept. IP, 1400 S. Second St., St. Louis 4, Mo. on your company letterhead.

220—Industrial Exhaust Fans

Industrial exhaust fan catalog 500B features the S-2 Exhaust Fan with descriptions of various applications, types, and construction. Complete dimensional data and capacity tables assist in application of this fan. Principles of application and engineering data for standard and long-cone Cyclone Separators are described and illustrated. Fort Worth Steel & Machinery Co.

Handling Bulk Materials

If you use equipment for handling coal, ore, or other bulk materials you need this 32-page illustrated booklet. It discusses mechanical, electrical, and structural features of such equipment in detail with photographs of typical installations. **Please send inquiries directly to Dravo Corp., Dept. IP, Crane and Bridge Dept., Neville Island, Pittsburgh 25, Pa. on your company letterhead.**

221—Chains and Sprockets

Catalog 950, 340-pages, with its flexible cover and thumb index will prove to be invaluable to the engineer interested in chains and sprockets for conveying, elevating, and power transmission. Tables of pre-engineered drives facilitate selection of standard roller chain drives and silent chain drives. Link-Belt Co.

Properties of Aluminum

Featuring much new information, the 1954 edition of "Aluminum Data Book" offers 220-pages of detailed data on properties and characteristics of aluminum. **Please send requests directly to Reynolds Metal Co., Dept. IP, 2500 S. Third St., Louisville, Ky. on your company letterhead.**

222—Fire Hazard Manual

"Fire Hazards and Safeguards for Metalworking Industries," 56-pages, is Technical Survey No. 2 of plant construction, process layout, and operations with a view to fire prevention. A better understanding of the principles of fire-safe construction along with fundamentals of production of hazardous operations, and importance of fire protection engineering will be gained from reading this bulletin. The National Board of Fire Underwriters.

223—Hand Threading Pipe

"Helpful Hints on Hand Threading Stainless Steel Pipe and Tubing," data card TDC-147, discusses die stock, dies, speed, cutting oils, and the assembly of threaded joints. It is intended to assist pipe fitters working with hand tools on

Reliability

ALWAYS PAYS OFF!

In any business a reputation for reliability is a priceless asset, because buyers can't afford to gamble—they must be *sure*. And such a reputation doesn't come by accident . . . it must be earned!

Year in and year out for nearly three quarters of a century, Bell & Zoller has maintained a reputation as an outstanding producer of top-quality coals for every type of burning equipment. Buyers have long known that coal bearing the B & Z name is a "sure thing" for maximum boiler efficiency and top transfer of heat energy into steam power.

You, too, can put your chips on our 68-year reputation for reliable analysis, and delivery, of the *correct* coal to meet your specific requirements.

COAL HEATING SERVICE

BELL & ZOLLER COAL COMPANY

BELL BUILDING, 307 N. MICHIGAN AVENUE, CHICAGO 1, ILLINOIS

CLEVELAND · NEW YORK · ST. LOUIS · MINNEAPOLIS · OMAHA
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Sixty-Eight Years of Service to Coal Users

Producers of
ZEIGLER, MOSS HILL, ORIOLE, MURDOCK, and BUCKHORN Coals

Sales Agents for

Spring Hill Mining Company
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Boone County Coal Corporation
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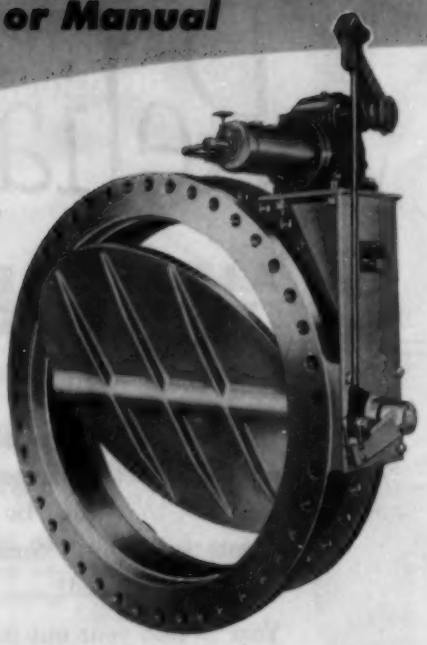
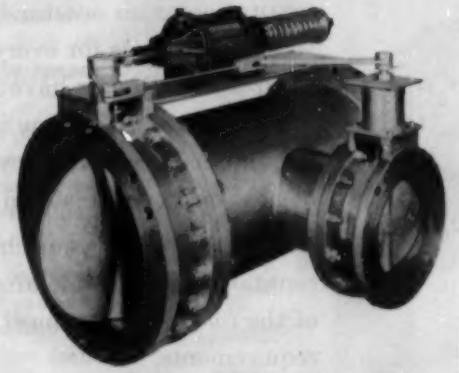
VALVES for AIR • GASES LIQUIDS • SOLIDS

Automatic or Manual



W. S. Rockwell 54" butterfly valve for low pressure air line in a power plant; equipped with automatic crank type air cylinder operator.

W. S. Rockwell 24" heavy duty, wafer butterfly valve with gear type handwheel operator to handle recirculating water to 125 p.s.i. at 125° F. in steam power plant.



W. S. Rockwell 3-way butterfly valve, 24" size on line and 14" on branch; operated by spring-loaded hydraulic cylinder and special safety controls against power failure. Handles air and exhaust gases to 60 p.s.i. and 350° F. in gas turbine units of 5000 KW generators.

These are examples of the many butterfly, slide and special valve types, Rockwell-designed and built, for industrial applications. What's your problem?

W. S. ROCKWELL COMPANY

ROCKWELL SINCE 1888 BUILT

BUTTERFLY VALVES • SLIDE VALVES • AUTOMATIC VALVES

2304 ELIOT STREET • FAIRFIELD, CONN.

Sales Representatives in Principal Cities

Circle 534 on Reply Card for more data

new bulletins

—Starts on page 36

job sites or in provisional field shops away from machine threading facilities. The Tubular Products Div. of Babcock & Wilcox Co.

224—V-Belt Drives

Engineering handbook 4-8155-G1 is a convenient guide to the design of standard and high capacity drives. The 76-page book includes new horsepower rating tables which permit design or re-design of V-belt drives at lower costs for speed ratings from 100 to 6000 ft per min. Selection, installation, and maintenance are also covered. B. F. Goodrich Co.

225—Transformer Differences

On the theme "all transformers are not alike," G. E. has prepared this 23-page booklet so that you can see for yourself how each of the eight "extra" features of G-E transformers brings you an extra benefit—greater reliability, or greater ease of handling, or reduced maintenance costs. General Electric Co.

226—Savings With Cooling Towers

The question of how cooling towers save you money is answered fully in four-page booklet 402-A on Flow-Cold Cooling Towers. The five models illustrated and described have capacities ranging from 3 through 15 tons. Acme Industries, Inc.

227—Package Boiler Controls

Specifications for the fully automatic, all electric metering type packaged control for shop assembled boilers are given in four-page bulletin 54-1088-230. Schematic drawing shows a typical packaged control system for a combination oil or gas fired boiler. The Hays Corp.

TO REQUEST FREE BULLETINS

Circle "key" numbers on Reply Card between pages 34/35 & 98/99. Your requests will be handled promptly.

228—Instrumentation Literature

This index of literature on instrumentation has been prepared for your convenience in obtaining data on any of the many products made by this company. Publications are divided into such sections as Catalog and Product Bulletins, Specification Sheets, Technology, and Services. Industrial Div. of Minneapolis-Honeywell Regulator Co.

229—Membrane Type Filters

Four-page folder F-1054 on permanent membrane type liquid filters explains precoating, filtering, and cleaning operations, with schematic drawings showing flow directions during each of these phases. The various uses for wire well screen, porous stone, or porous carbon membranes are pointed out. Filter Div. of Wagner Brothers, Inc.

230—Bronze Valves

Bulletin 110 describes the new 500 Brinell line of bronze globe and angle valves. Kenalloy, a new valve stem material, is described along with other features such as "bottle-type" seats and discs, and the Higbee-Cut Acme thread. Kennedy Valve Mfg. Co.

(Continued on page 102)

This simple idea saves money in V-Belt Costs

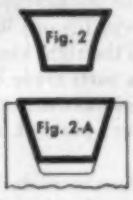
You can prove it in two minutes!

To prove how the CONCAVE SIDES of GATES VULCO ROPES *save money*, just make this simple test—

Bend *any* V-Belt that has *straight sides* (Fig. 1) and—as the belt bends—*feel* the sides *bulge out* (Fig. 1-A). This out-bulge concentrates the wear at the points shown by arrows—and this naturally shortens the life of a *straight-sided* belt!

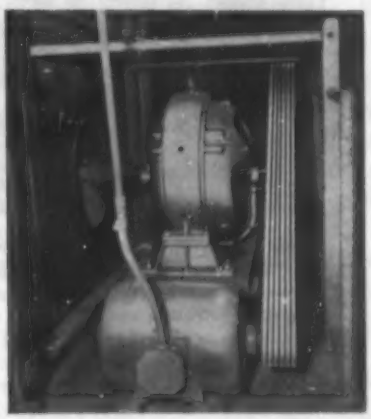
Now bend a Gates Vulco Rope with CONCAVE SIDES (Fig. 2)

(U. S. PAT. 1613699)



You find that the CONCAVE SIDES *fill out* and become perfectly straight. They thus press *evenly* against the V-pulley. All wear is distributed *uniformly* across the *full width* of the GATES VULCO ROPE—and this means *longer* belt *life* and *lower* belt *cost* for you!

When you buy V-Belts, be sure to get the V-Belt with the CONCAVE SIDES—the GATES VULCO ROPE!



Typical Gates Vulco Rope Drive — the Gates V-Belts are built with Concave Sides to insure longer belt wear.

VULCO ROPE DRIVES

THE GATES RUBBER COMPANY
DENVER, U.S.A.

Gates Engineering Offices and Jobber Stocks are located in all industrial centers of the United States and Canada, and in 70 other countries throughout the world.

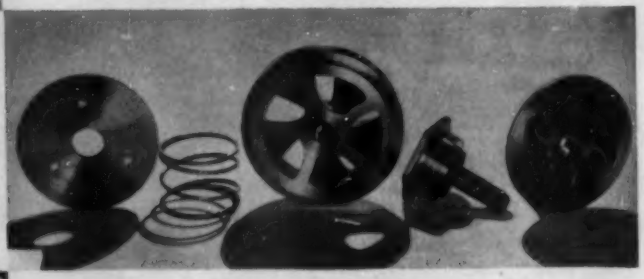
CS-545

Circle 535 on Reply Card for more data

"K" Monel pump shaft being installed by utility company to avoid costly periodic breakdowns previously encountered with steel shafts in pumps circulating polluted and corrosive salt water. "K" Monel can be heat treated for great strength and hardness.

Monel pump valve for reciprocating circulating water pump withstands severe erosion-corrosion. Monel's tensile strength and resistance to fatigue are as high or higher than those of structural steel.

Ripe old age for pump parts



Cast "S" Monel liners reduce wear on pistons where gritty corrosive liquids are found. The resistance of "S" Monel to cavitation-erosion makes it ideal also for impellers in centrifugal pumps. Users have reported "S" Monel impellers lasting 3 to 30 times longer than other materials.

Some pumps are built to last; others aren't. But you can increase the service life of your pumps if you choose pump parts with the right kind of "life insurance." That means parts made of materials with exceptional resistance to corrosion, fatigue, erosion and wear; parts of high strength and hardness.

Outstanding among these more durable materials are the Inco Nickel Alloys like Monel®, "K"® Monel and "S"® Monel. A majority of pump users have found that with these alloys, pump parts last much longer.

The next time *you* have to repair one of your pumps, ask your pump manufacturer to duplicate the part in one of the Inco Nickel Alloys. And write Inco for the helpful booklet, *How to Get Longer Service from your Pumps.*

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

More POWER for you . . . with MONEL

INCO TRADE MARK **Nickel Alloys**

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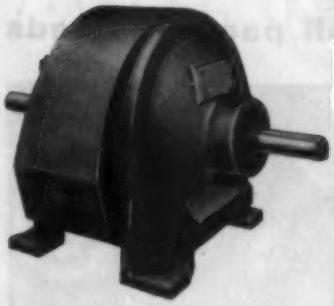
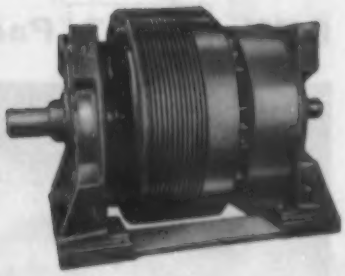
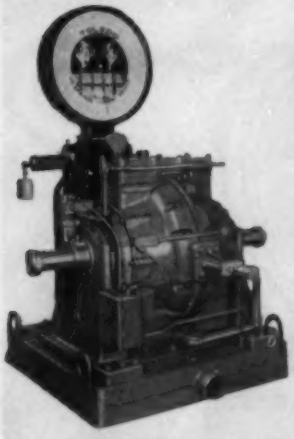


AIR COOLED COUPLINGS

AJUSTO-SPEDE MOTORS



PRESS DRIVES

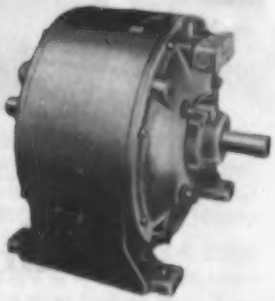


DYNAMOMETERS

AIR COOLED BRAKES

LIQUID COOLED COUPLINGS

Our new booklet, "Bulletin GB2," describes and illustrates the basic Dynamatic Eddy-Current units, including the new Stationary Field Coupling. If you are interested in modern speed control, write for your copy.



LIQUID COOLED BRAKES

Speed Control Problems?

One of these Dynamatic Units may be the solution

Dynamatic Eddy-Current Couplings, brakes, clutches, Dynamometers, and Ajusto-Spede motors, in use today in practically every basic industry—in both plant equipment and end products—are proving the ideal solution to difficult speed control and testing problems. Advantages include rapid response, infinitely adjustable speed control, wide speed range, quiet operation, high full-load efficiency, low maintenance cost, adjustable speed from an AC power source. Write for your copy of the new Dynamatic Bulletin GB2 today.

DYNAMATIC®

DIVISION EATON MANUFACTURING COMPANY

KENOSHA, WISCONSIN • General Offices: Cleveland, Ohio

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R/M's BIG 7 Packing Types meet 95% of all packing needs

High speed rotary compressors like this one which supplies pneumatic tools with 230 cubic feet of actual free air per minute—compressing it from atmosphere to 100 lbs. gage—give top performance with R/M Packing No. 920, a packing included in Type 3 of R/M's Big 7 Packing Types.

With R/M you can practice P/M

By R/M we mean R/M packings. And by P/M we mean preventive maintenance. Hundreds of plants have already put an end to costly corrective maintenance by standardizing on R/M's Big 7 Packing Types. You can too. For this basic line of just seven field-tested packings (you probably need only three or four) is engineered to give custom-built performance in all but the very rarest applications. You can count on them to lower your inventories, reduce your downtime, cut your maintenance costs, and simplify your ordering. For details, call in your R/M distributor.

R/M PACKINGS FOR MAINTENANCE PURPOSES ARE SOLD ONLY THROUGH AUTHORIZED R/M DISTRIBUTORS

R/M

RAYBESTOS-MANHATTAN, INC., PACKING DIVISION, MANHEIM, PA.

BIG 7 PACKINGS

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada.

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ALL FORGED STEEL

Edward UNIVALVES

Lower Pressure Drop 25-50% with Straight-Thru Flow

As shown photographically here, the streamlined internal contours and the inclined stem construction of the Edward Univalve give straight through flow — which careful laboratory tests have shown to result in pressure drop 25 to 50% lower for Univalves than other globe valve types. Turbulence, too, is greatly lowered by these streamlined contours. And lowering turbulence lengthens valve life by eliminating vibration, the principal cause of wear in small globe valves.

But lower-pressure drop and less turbulence are not the only reasons the Univalve has become an industry standard for tough high pressure, high temperature services. Here are just a few of the benefits which add up to longer life and lower maintenance for this outstanding all-forged Steel Valve.

LONGER PACKING LIFE **through a positive backseat and deep cooling chamber which protects packing in service. Isolation of packing prevents blow-out when repacking under pressure.**

PERFECT ALIGNMENT, EASY DISASSEMBLY **when necessary, through foolproof patented body-bonnet connection.**

EXTRA WEARING SEATING SURFACES— **seat formed by application of continuous ring of Stellite to valve body; Stellite hard-facing applied to alloy steel disk.**

EASY PACKING ADJUSTMENT **with through bolted, accurately guided gland.**

EFFORTLESS SEATING **with impacter handwheel in sizes 1¼ in. and larger.**

DESIGNED FOR HIGH-PRESSURE, HIGH-TEMPERATURE APPLICATIONS
Two different classes rated for 1500 lb sp at 1023F or 2500 lb sp at 1033F.

AVAILABLE IN A WIDE RANGE OF SIZES
Furnished in 1500 lb or 2500 lb pressure classes in sizes from ½ in. to 2 in.

CHECK VALVES, TOO
Check type Univalves, of spring loaded piston design, have the same basic construction as globe Univalves. Use them together for all welded construction for small pipe lines, eliminating all bonnet joint leakage problems.

IDEAL FOR BLOW-OFF SERVICES
Univalves meet all ASME code requirements for blow-off service and are adaptable for high pressure installations to 3120 psi boiler pressure.

Get the full story on Univalves, ideal all-purpose steel valves—write for Catalog 1201.

Rod through Univalve demonstrates straight thru flow of this valve.

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Subsidiary of ROCKWELL MANUFACTURING COMPANY
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Another Product

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NO Reducing Valve Needed

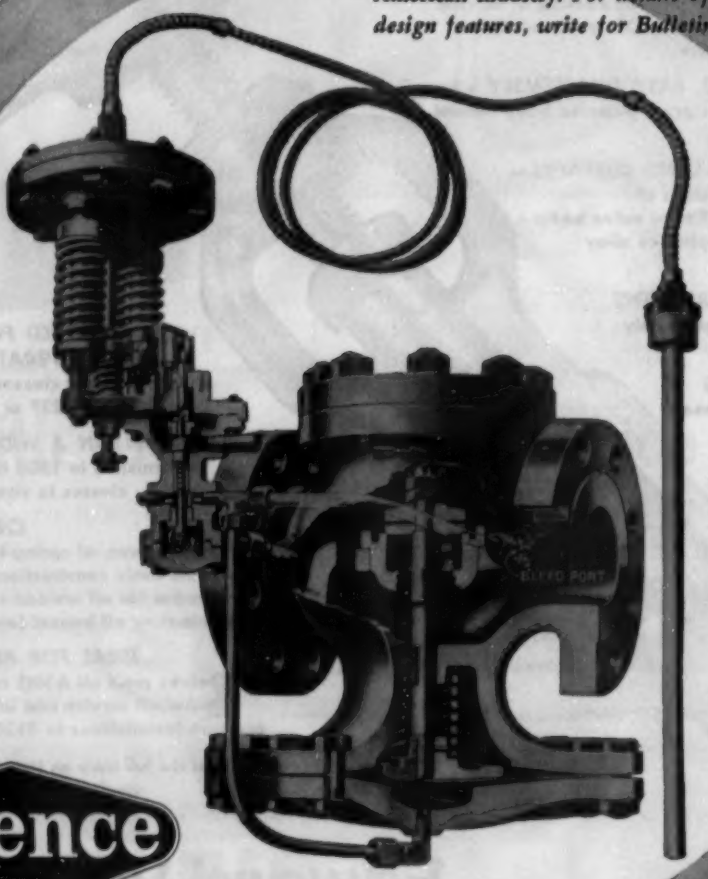
Here's real economy in temperature control.

Because Spence Temperature Regulators are designed to limit heater steam pressures to an adjustable maximum, the need for a separate reducing valve is completely eliminated.

The Spence Regulator takes steam directly from the boiler or high pressure line, reduces the pressure and regulates the flow as required to maintain a constant temperature output from the heater.

This means one relatively small combination pressure and temperature regulator replaces a reducing valve of the same size and a larger temperature regulator. Practically the entire cost of the large separate temperature regulator is saved. And, the total saving would also include the cost of a 3-valve by-pass along with all labor for installation.

This design feature is just one of the reasons for the thousands of Spence installations throughout American industry. *For details of other important design features, write for Bulletin T50.*



SPENCE
TYPE ET150
Temperature
Regulator

Spence

SPENCE ENGINEERING COMPANY, INC.
WALDEN, NEW YORK

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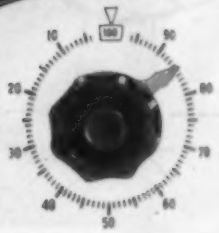
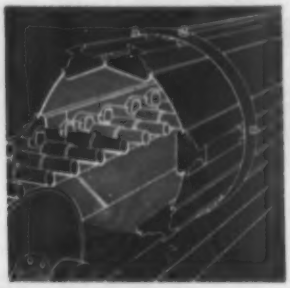
uniform heat . . .
precise heat . . .
fast heat . . .
"**color blind**" heat . . .

A tough, compact, far-infrared generator that fastens to simple framing for economical ovens in dozens of shapes. Only 3¾" wide; lengths 2 to 12 ft.; 0.6 to 7.2 Kw.; all standard voltages; 5100 BTUs per sq. ft. per hr.



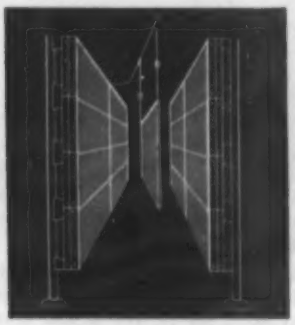
TWO JOB-PROVED FAR-INFRARED TYPES TO CHOOSE FROM!

You'll find Chromalox pre-built Radiant Panels and Heaters from stock fit your jobs and your budget. Shown below are just two of the literally hundreds of oven shapes and sizes which can be erected quickly and easily using Chromalox Electric Radiant Units.



Conveyorized oven built on the job using Chromalox Radiant Heaters. Units are installed in lengths and ratings needed to fit the work. Input controller gives precise and exact temperatures easily adjusted to meet varied processing requirements. Easy to assemble, easy to wire.

Complete oven components with built-in insulation, frame, preheating airways and 100 ampere bus — come ready to erect and connect. Sizes 1 x 4 ft. and 2 x 4 ft.: 10.8 and 21.6 Kw.; all standard voltages. 9200 BTUs per sq. ft. per hr.



Chromalox pre-engineered Radiant Panels are easily and quickly erected and connected to form ovens and drying tunnels of any size and shape. An oven such as sketched may be installed in 20 to 30 man-hours with minimum engineering expense and lowest cost per installed kilowatt.

A Chromalox Electric Radiant Panel or Chromalox Radiant Heater installation gives you a quick, low-cost answer to your baking, curing, drying and other heating needs. Pre-engineered units allow on-the-spot erection and connection. You get up to 700° F. work temperatures; absolutely uniform radiation with no hot and cold spots; high intensity heat that's absorbed *f-a-s-t* by all colors; and accurate "dialed" heat from 0 to 100% of capacity.

CHROMALOX *Electric*

Far-infrared Units

Have a Problem Involving Degreasing, Drying, Baking, Preheating, Curing?

The assistance of Chromalox Application Engineers is yours for the asking. They'll help you work out your specific requirements without obligation. Write today.

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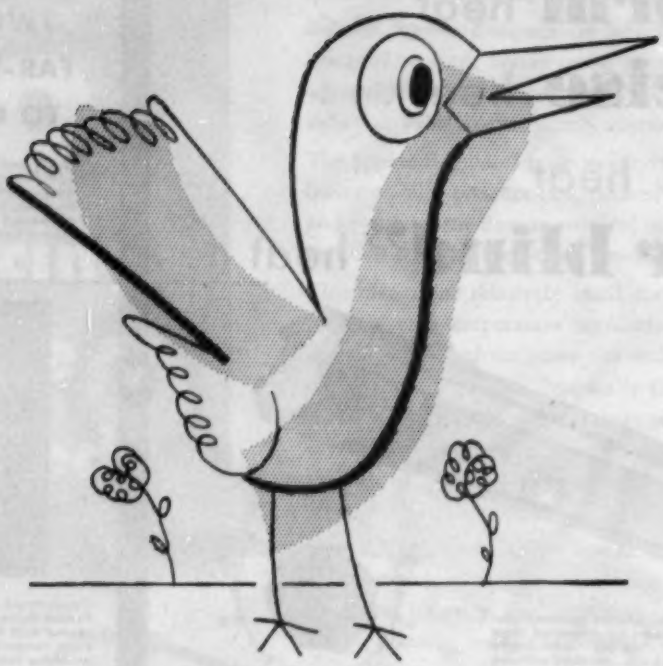

HARD WATER IS FOR THE BIRDS

Maybe birds and flowers like hard water—but we doubt it. Most people don't. Especially those who use large quantities of water, as needed for boilers, processing, water heaters and other services, where ordinary water just won't do.

And that's where Elgin-Refinite comes in. Water softening and conditioning is our business. We have been at it for nearly a half century during which we have come up with some of the most important developments in the field.

For example, our water softener of "Double-Check" design makes possible a deeper zeolite bed which increases soft water output as much as 44% —yet it costs so little more. The ingenious "double-check" arrangement also prevents costly loss of zeolite (this arrangement can be easily installed in your present water softener).

High capacity Elgin zeolites give 3 to 10 times more capacity of soft water output per regeneration. And then there is the outstanding Elgin Ultramatic Water Softener—today's finest fully automatic water softening equipment. Its automatic control mechanism is readily adaptable to any existing water softener.

Yes, if you require soft water in large or small quantities, or any of the water conditioning equipment shown below, let us put the nearest Elgin-Refinite man in touch with you.

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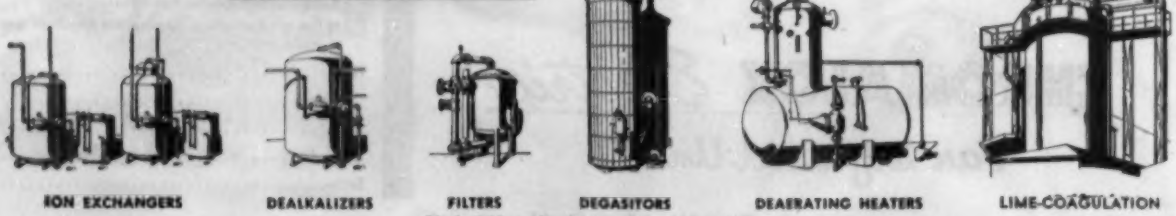
Elgin REFINITE SINCE 1908

Water Conditioning since 1908



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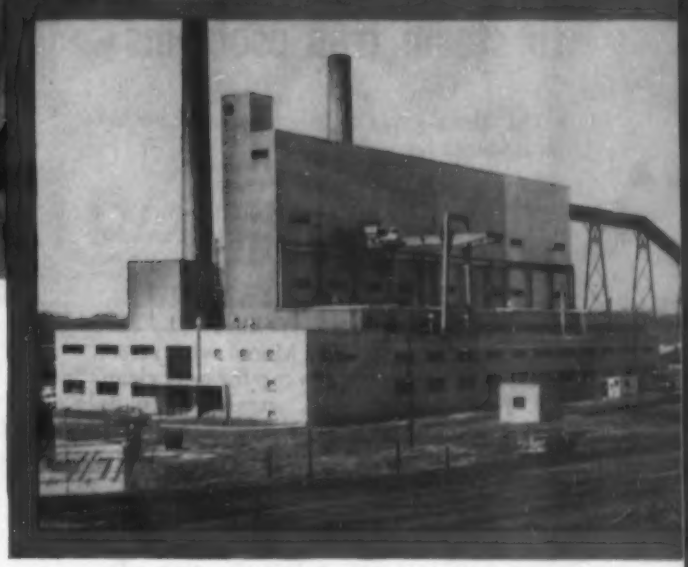
On-the-spot help and advice is part of the job for every Standard Oil lubrication specialist. Here Chief Operator G. C. Barlow and Standard's R. R. Spargo examine color and clarity of NONPAREIL during regular periodic check-up.



"We picked the only oil with a turbine life-time guarantee!"

NONPAREIL
TRADE MARK
Turbine Oil

STANDARD

■ "When our new Power Plant was planned, your turbine oil guarantee impressed all concerned at the Corn Belt Power Cooperative at Humboldt, Iowa," says Chief Operator G. C. Barlow. "Only Standard offered a guarantee on turbine oil for the life of the turbine—so we chose Standard's NONPAREIL Turbine Oil—and we've been completely satisfied since."

Specifically, Standard guarantees that the acidity of NONPAREIL Turbine Oil will never exceed a neutralization number of 0.15 KOH/gm. This means an absence of sludge and deposits in governors and filters. The whole system stays clean. The oil never needs to be removed for treating or cleaning.

Corn Belt's first three turbines were initially filled with NONPAREIL Turbine Oil in 1950 and 1951. Since then periodic checks have shown that the neutralization number has never exceeded 0.04 KOH/gm. The turbines have operated perfectly without *any* cleaning or changing of oil. Naturally, when a fourth turbine was recently added it too was filled with NONPAREIL.

NONPAREIL has been making records like this in turbines large and small for more than 25 years. For this kind of guaranteed superior lubrication in *your* plant's turbines—new or old—fill with NONPAREIL. A Standard Oil lubrication specialist will be happy to show you the facts and data on NONPAREIL's history in installations similar to yours. Call your nearest Standard Oil office or write: Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

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YARWAY IMPULSE STEAM TRAP . . .
the steam trap that gets equipment *hot in a hurry and keeps it hot.* Small size, light weight, *body and all working parts of stainless steel.* Low cost, low maintenance.

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32 trained YARWAY engineers working out of YARWAY branch offices from coast-to-coast, are constantly helping on *trap selection, installation maintenance* and *operation.* Solving your trap problems is their job. It will cost you nothing to call them in to assist you.

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• YARWAY IMPULSE STEAM TRAPS AND STRAINERS are immediately available from more than 250 Industrial Distributors in the United States, Canada, and other countries. For name of one nearest you and FREE Steam Trap Bulletin write . . .

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I&P EXCLUSIVE

A 2000 kw turbine generator produces up to 45 percent of the plant's electric requirements as a by-product of the process steam. The primary switchgear is installed along one wall of the generator room.

Power Service

Archer-Daniels-Midland's New Plant Generates Process Steam Plus By-Product Power

D. K. MORRILL, Chief Engineer
Archer-Daniels-Midland Company

A CONTINUOUS supply of steam in relatively large quantities is required to process soy bean and linseed oils. An interesting example is the milling and oil extraction operation at Archer-Daniels-Midland Company's 29th Ave., SE, plant in Minneapolis. When this plant's process steam demands outgrew its steam generating capacity, a consulting engineering firm was retained to conduct preliminary studies and submit recommendations for new steam generating facilities.

Preliminary Studies

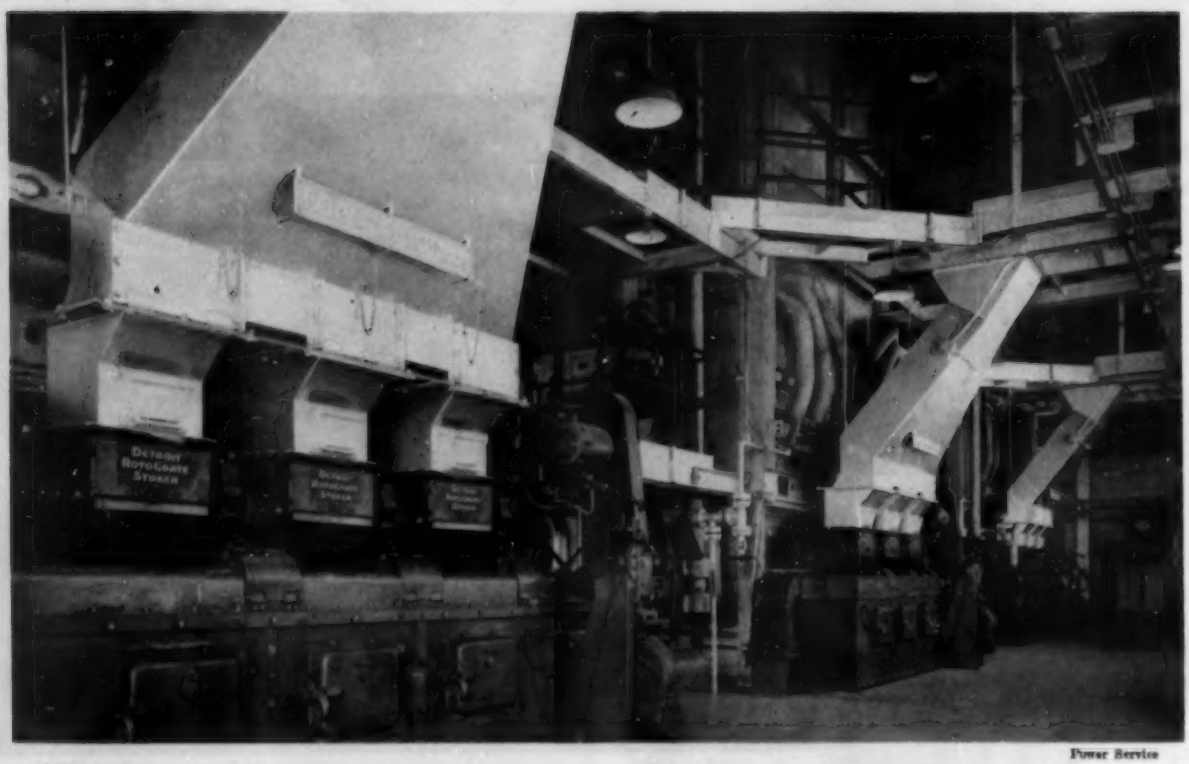
In view of the large process steam demands, the consultants studied the possibility of generating a portion of the plant's electric power requirements as a by-product of the process steam. Electric power rates in this area are relatively high. Also, although outages of power from the utility are rare, a loss of power seriously disrupts some of the processes within the plant. In fact, some of the oils being processed set up like glue if they are not kept moving. Therefore, the fact that an in-plant generator could serve as a second source of electric supply to these particular processes proved to be an important factor in favor of power generation.

Process steam requirements in this plant are largely at two pressures — 170 and 70 psig. Thus, studies were made to compare the generation of steam at 175 psig and 500 F for process only with the generation of steam at higher pressures, using a back pressure type turbine generator to produce electricity. These studies indicated that a considerable saving could be realized by generating electricity as a by-product of the process steam. Based upon the price of fuel at this plant, it was found that the cost of the fuel required to generate the electricity would not exceed 1½ mils per kwh.

On the basis of these studies, the consultants recommended in-plant generation of a part of the plant's electrical requirements.

Selecting Steam Conditions

Another problem encountered in the preliminary studies was the selection of steam conditions to economically provide for the generation of the greatest possible amount of electricity on a by-product basis. Studies were made to compare the



Power Service

Two boilers are normally operated, one serving as a standby unit. All units are equipped with gas burners and stokers.

use of steam at 400 psig and at 600 psig. Although the use of 600 psig required a somewhat greater initial investment for equipment, it proved to be more desirable than the lower pressure because it permitted the generation of 33 percent more electricity.

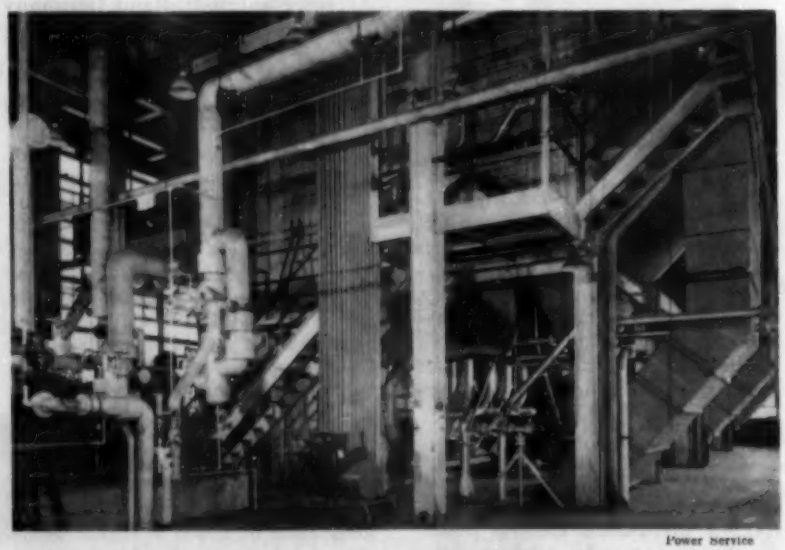
The existing boiler house had become obsolete and the boilers and related equipment were in need of repair. Also, the boiler plant itself had not been planned for the generation of power. It was therefore decided to abandon the old boiler house in favor of an entirely new power plant. It was felt that the cost of a new plant, as compared to modernizing and expanding the old boiler house, would be outweighed by the better performance and the higher operating efficiencies afforded by a well-designed, completely integrated plant.

Design Features

Three, 45,000 lb per hr, water-tube boilers and one 2000-kw automatic extraction-back pressure type turbine generator have been installed in the new power house. Sufficient allowances have been made in the general layout of the plant for extra expansion. Additional steam generating units can be easily installed by extending the length of the boiler room.

The boiler instrument panels, stokers, feedwater pumps, turbine generator, and primary switchgear are located on the first floor so as to be convenient to the operators. An interior wall divides the generating room from the boiler room.

All exterior walls of the plant are faced with yellow brick on the inside, and large window areas are provided in the generating room, in front of the boilers, and at various



Power Service

Large ducts carry preheated air to primary air chamber beneath stoker grates. The boiler-pass hoppers and the fly ash reinjection system also can be seen.

elevations along the back wall, thus creating a light, airy atmosphere.

The generator, rated at 2000 kw at 3600 rpm, is driven by an extraction-noncondensing, 8-stage straight impulse turbine which serves as a pressure reducing and partial desuperheating station for the process steam. Design conditions for the turbine call for an initial steam pressure of 590 psig and initial temperature of 815 F, with automatic extraction at 170 psig and exhaust at 70 psig. When generating at 2000 kw, 50,000 lb per hr of steam may be extracted.

Electric Power Generation

Electricity is generated at 4160 volt, 3 phase, 60 cycle. Purchased power, coming into the plant through a 2-way feed from the utility, is at 13,800 v and is reduced to 4160 v by three 2000-kva, OISC, single phase transformers mounted on a concrete pad on the ground adjacent to the generator room.

The turbine normally operates in parallel with the utility, with the power company determining the frequency, and it is governed by the back pressure of the exhaust steam line. The amount of in-plant generation is controlled by the combined 170 and 70 psig steam demands. Normally, the byproduct power production approximates up to 45 percent of the plant's electric requirements.

Since the generator does not have sufficient capacity to produce all of the electricity needed by the plant, the switchgear is arranged to automatically cut off all but two of the circuits if the purchased power fails. The two circuits remaining on the line are the feeder supplying auxiliary station power and one feeder serving certain mill processes that should not be interrupted.

When the power company lines fail, all the electric load is thrown onto the turbine, thus causing the frequency to drop. This, in turn, trips all the circuit breakers except the two which must remain in service. With all but two of the feeder circuits off the line, the turbine speeds up and a frequency governor becomes engaged. The turbine then operates as a frequency governed machine supplying the electric requirements of the two circuits. If the prevailing process steam flows cannot generate the electricity required by these two feeders, the turbine exhaust pressure will increase and an atmospheric relief valve will discharge sufficient steam to meet the power demand.

When service from the utility is restored, all circuit breakers are again closed and a manual reset on the turbine returns it to back pressure governing.

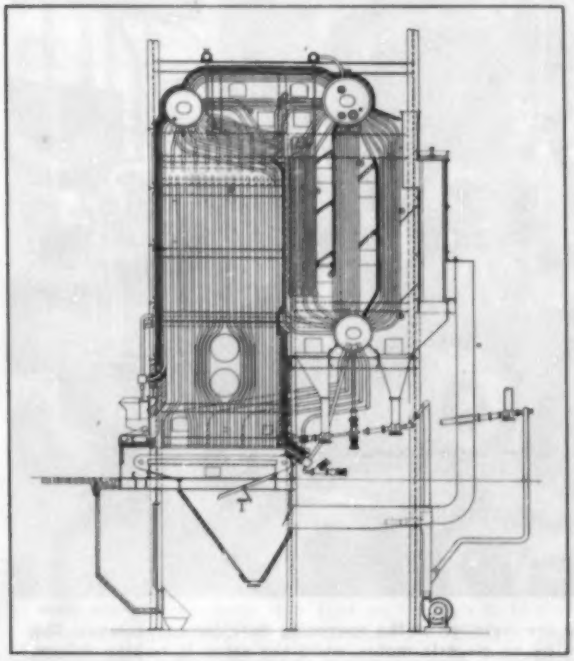
Desuperheating Stations

Steam from the boilers is at 600 psig and 825 F. The high pressure process requirements are extracted from the turbine at 170 psig, 630 F, and are passed through an atomizing jet-type desuperheater which reduces the temperature to 475 F. The low pressure requirements exhaust from the turbine at 70 psig, 525 F, and go into the process steam line at approximately 475 F. Since the processing equipment is located some distance from the power plant, the steam actually is used at near saturated conditions.

Four electrically driven pumps supply the desuperheating stations with condensate. Two of these units are vertical pumps for the 70 psig desuperheating station, while the other two are horizontal units, operating in series with the vertical units, for the 170 psig station. One pump of each type is normally operated, while the other two units serve as standbys. All pumps are cross-valved so that any unit can be removed without interrupting the flow of condensate.

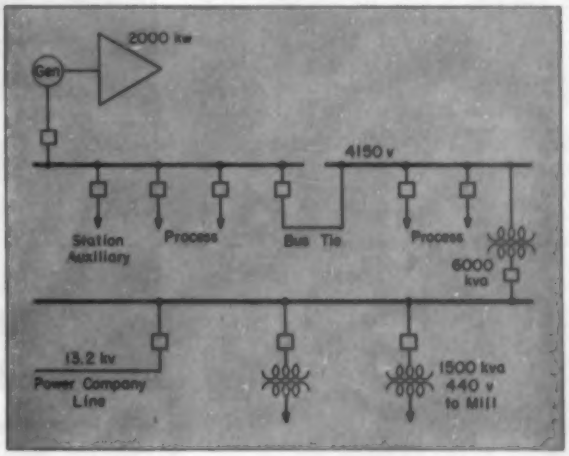
Pressure Reducing Stations

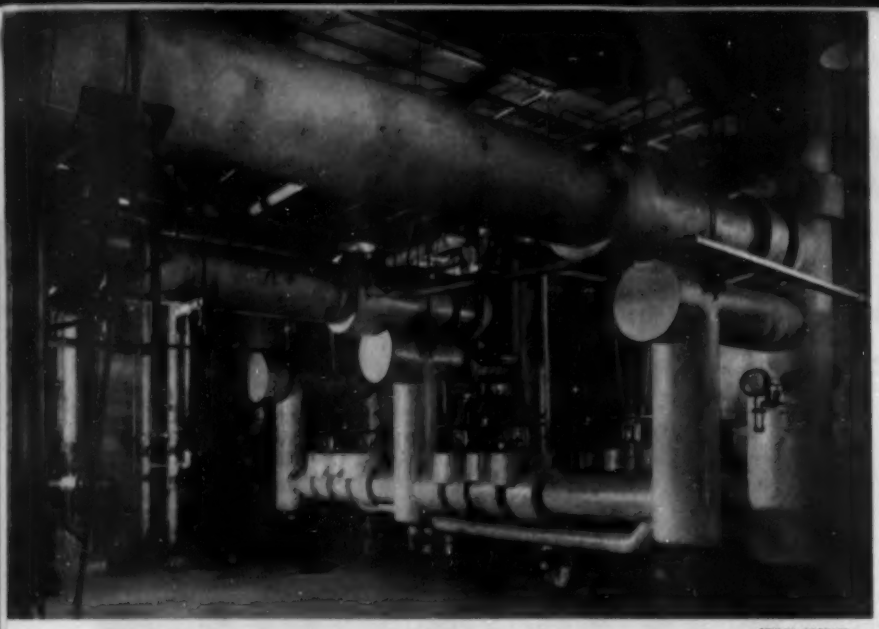
Pressure reducing stations are provided for each process steam line. The high pressure station, which reduces steam from 600 to 170 psig, leads directly from the main steam header to the high pressure process steam line. A second station, which reduces the steam from 170 to 70 psig, connects the two lines. For flexibility of operation, each station consists of two pressure reducing valves so ar-



Drawing shows design of boilers and arrangement of superheaters, air preheaters, stokers, and gas burners.

Electrical diagram of the plant. All but two of the circuits are cut off if power company lines fail.





Two pressure reducing valves at each station provide flexibility of operation. Desuperheaters can be seen in the vertical lines immediately below the ceiling.

ranged that one unit is relatively close to full capacity before the second starts to open.

Additional Steam Requirements

Besides the requirements for saturated steam at 70 and 170 psig, there are a few processes in the plant requiring higher and more consistent temperatures than can be supplied by the 170 psig steam line. Some of these processes use 400 psig, 510 F steam, while others are supplied by two Dowtherm vaporizers located in a second boiler house. Both Dowtherm units are gas fired, with oil as a standby. The larger vaporizer is rated at 4,500,000 Btu per hr and operates at 53 psig and 650 F, while the smaller unit is rated at 2,200,000 Btu per hr and operates at 32 psig and 600 F.

Many of the processes within the plant require a cooking period of as much as fifteen days, and if they were to lose steam the entire batch would be spoiled. Thus, the need for a continuous supply of steam determined the number and size of the steam generators to be installed in the new power house.

Boiler Design

Any one of the boilers, rated at 45,000 lb per hr continuous and 55,000 lb per hr for two hours, can meet the normal process steam requirements for the entire plant. However, two of the three boilers are normally operated so that if a boiler should fail, the plant would not lose its process steam.

Each of the steam generators is a 3-drum, bent tube unit with a fully water-cooled furnace, superheaters, and air preheaters. The boilers are equipped with mechanical draft fans, soot blowers, automatic feedwater regulators, and bi-color water level indicators.

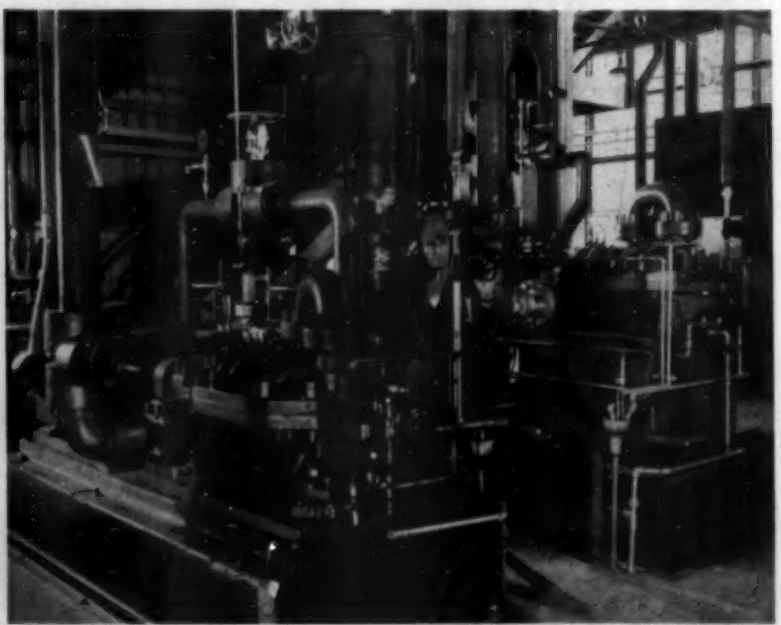
All auxiliary boiler equipment is electrically driven. In addition, one boiler is equipped with dual drives —electric motor and steam turbine. Although the possibility of a complete failure of station power is remote, this arrangement makes it possible for one boiler to remain on the line or to start up in the event that a complete electrical outage should occur.

All the turbines are manually started and all but the boiler feed pump turbine operate on 170 psig steam taken from the turbine unit's extraction line. If the turbine generator is not operating, steam is obtained form the 600 psig steam header through a pressure reducing valve. The turbine driven boiler feed pump operates on steam directly from the 600 psig header.

Dual Firing

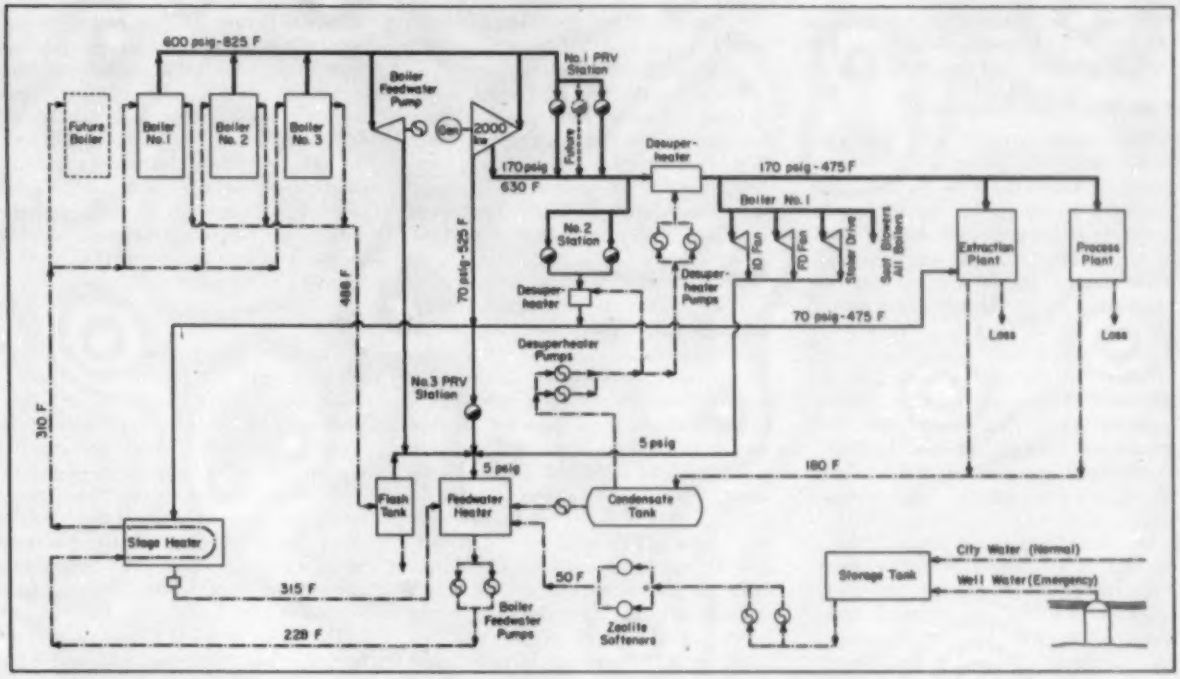
The boilers are equipped for dual firing, each unit having two gas burners and a spreader stoker having three feeders and a continuously forward moving grate that discharges the ash at the front. The burners are mounted in the left wall of each boiler, one directly above the other. Steel grating walkways are provided for servicing. Each burner is fully equipped with safety controls, such as low water, furnace back pressure, flame failure, and air failure cutouts.

The active stoker grate area is 9-ft, 1½ in. wide by 12-ft, 8-in. total length, with the grates discharging into an ash hopper at the front. A variable speed drive is provided for controlling the grate speed so that the operator can



Goulds Pumps

The feedwater pumps are installed on the operating floor for convenience. The nearer unit is driven by an electric motor while the other is turbine driven.



Flow diagram shows piping arrangement of pressure reducing and desuperheating stations and other principal equipment.

maintain a desired depth of ash. The speed of the feeder rotors also can be controlled by a variable speed drive to maintain an even spread of fuel at all times. The rate of coal feed, the amount of underfire air, and the furnace pressure are automatically controlled by pneumatically operated combustion controls.

Primary air at approximately 250 F is supplied through an undivided air chamber underneath the grates. The front furnace arch is air cooled, and overfire air jets are located in this arch to provide turbulence in the furnace while firing coal. Additional turbulence is gained by reinjecting fly ash through the rear furnace wall.

Dump Rate for Gas

Coal was originally selected as the fuel for the boilers. However, during the design stages of this power plant, the gas company offered a dump rate for the use of interruptible gas. Gas, therefore, is normally used as fuel. This gas is presently being purchased for 33¢ per 1000 cubic feet. The amount of gas available will vary depending upon weather conditions. Normally, however, less than 1500 tons of coal are burned per year.

Changing over from one fuel to the other requires about 15 minutes. When changing from coal to gas, the stoker feed units and grates are stopped and the coal is allowed to burn down. The ash, normally 2 to 4 inches deep, is left on the grates for protection. Also, a flow of water through the water-cooled bearings on the spreader feed unit rotors is maintained so that these bearings will not be damaged by heat. However, it is not necessary to keep the rotors of the feeders in motion. If gas is to be burned for an extended period of time, all of the coal is normally burned out of the bunkers before the changeover is made so that fresh coal will be available when the stokers are again put into operation.

Selection of Coal

Ohio coal is usually burned in this plant. This coal, Pittsburgh No. 8, Harrison Seam, averages 13,536 Btu per lb on a dry basis. Ash content is 6.71 percent, and the fusion point is 2250 F.

The Ohio coal is obtained from the Lake Superior docks at Duluth, and the delivered price is $10.06 per ton. This price compares to about $9.00 to $9.25 for Southern Illinois coal having approximately 12,000 Btu per lb and a considerably lower ash fusion temperature than the Ohio coal. Delivery of coal from Duluth is made in from 3 to 5 days —another important factor favoring this coal. Also, during wet winter weather, coal shipped from Illinois may be frozen to a depth of more than one foot, making unloading difficult, while coal from Duluth is seldom frozen more than 3 to 4 inches deep.

Coal and Ash Handling

The coal comes into the plant by railroad. It is dumped through a grating beneath the tracks and a drag chain conveyor elevates it to the bunkers. Each boiler has an individual 100-ton bunker providing live storage capacity. All coal is weighed by automatic coal scales before passing into the stoker hoppers.

A coal storage area is provided in the yard, and the plant's usual practice is to have approximately 2000 tons of coal on hand in the fall. The coal in the yard is spread and reclaimed by a drag line.

Ash is handled by a steam actuated pneumatic type conveyor. The conveyor lines, installed flush with the basement floor, receive ash from the stoker ash hoppers and also a small amount of ash which sifts through the grates into the primary air chamber. This conveyor elevates the ash to a storage silo designed to discharge into trucks through a rotary dustless unloader.

Ash hoppers, directly below the boiler tube banks, collect the heavier fly ash dropping out of the gas

stream. The remaining fly ash is collected in tubular collectors. All fly ash is reinjected into the furnace.

Auxiliary Boiler Equipment

Individual forced and induced draft fans are provided for each steam generator. These fans are mounted on a steel frame, reinforced concrete balcony above and in back of the boilers. All fans are equipped with electric motor drives, and the fans on the one boiler have steam turbine drives as well.

The boiler combustion controls operate on compressed air at 40 psig and the boiler instrumentation uses air at 28 psig. These requirements are met by an 8 x 9-in. reciprocating compressor driven by a 25-hp electric motor. The instruments and controls also are tied into a compressed air main supplying air to the manufacturing plant. Altogether, there are 10 air compressors installed at various locations in the plant. One unit, supplying compressed air for process, is located in the power house basement and a second unit will be installed there in the near future.

Two 6-stage centrifugal feedwater pumps are provided. These units are installed on the operating floor. One pump is driven by a 200-hp, 440-v, 3-phase, 60-c induction motor, while the second is principally a standby unit and is driven by a 180-hp steam turbine. In addition to the automatic feedwater regulators on the boilers, each pump is equipped with an excess pressure governor. The governor on the motor-driven pump controls the discharge line of the pump, while the governor on the steam-driven pump regulates the steam at the throttle of the turbine.

Since most of the process steam is used for extraction of oils, it may become contaminated and therefore is not returned to the boilers. Approximately 85 percent makeup water is required. Water treatment and supply are therefore important.

Feedwater Supply

Well water is available but is not normally used because of its hardness—approximately 21 grains. City water is between 5 and 5½ grains. The city water is stored in a 50,000 gallon tank located in the basement. A two-tank zeolite water softener, also installed in the basement, reduces the water to a hardness of 0 grains. The capacity of each tank is 118 gpm, and each unit softens approximately 135,000 gallons of water before regeneration is required. The regeneration cycle is manually controlled, and the salt used for this purpose is purchased in carload lots.

From the softener, the water passes to deaerating heaters which raise its temperature to 228 F. The boiler feed pumps then pump the water through a closed stage, tube and shell heater which raises the temperature to 310 F. Two chemical feed pumps add sulfite and Nalco 752 into the boiler feed pump suction line. These chemicals are added continuously. Two additional chemical feed pumps add phosphate into the boiler drum—an analysis being made every 4 hours to determine the amount required.

As a result of the well planned, modern layout of this power plant, operating and maintenance labor has been held to a minimum. The over-all performance of the plant is very satisfactory, and the boiler efficiency averages between 76 and 79 percent when burning gas. Although the intermittent use of coal does not permit an accurate calculation of boiler efficiency when burning coal, it generally varies from 74 to 80 percent.

Operating Data

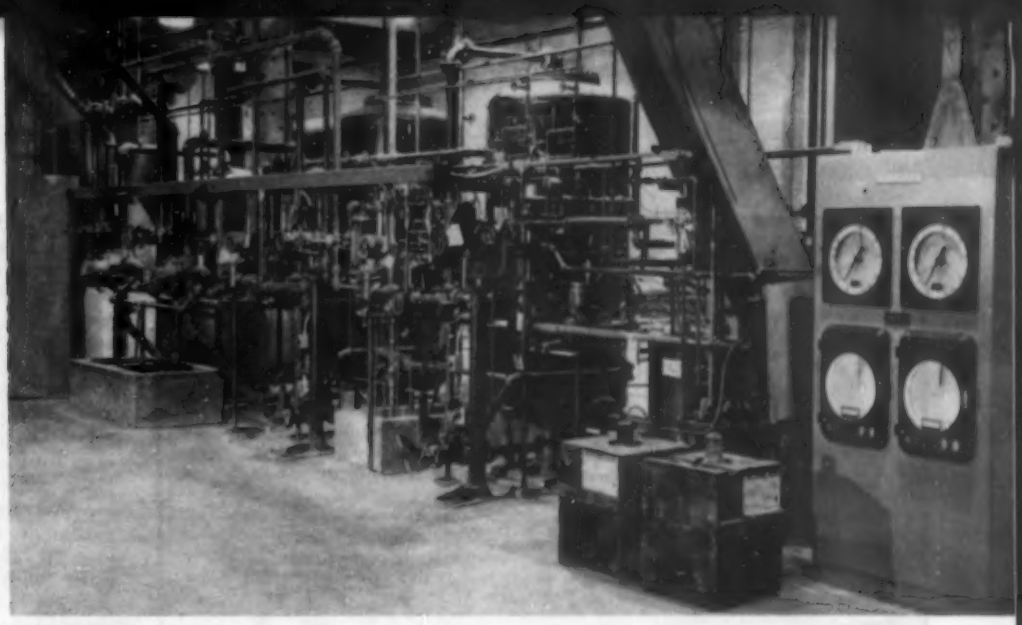
The total steam generated by this plant during the year ending June, 1952 was 325,379,200 lb. In the following year, only 288,220,300 lb were generated. This cannot be considered as a representative figure because the plant was shut down for several months as a result of a labor dispute. During these same periods, the total electrical generation was 6,039,000 kwh and 5,348,000 kwh.

The cost of steam, including labor, averages between $.65 and $.72 per 1000 lb. For accounting purposes, such indirect costs as taxes and depreciation on the equipment and building are added to these figures, so that the steam costs recorded for the fiscal years of 1952 and 1953 were $1.08 and $1.10 per 1000 lb of steam.

When calculating the cost of the electricity generated, the labor, depreciation, taxes, and other indirect costs are prorated. For the two fiscal periods under discussion, these costs were recorded as 0.95¢ and 0.99¢ per kwh. This compares to the base rate of 1.3¢ per kwh currently being charged by the utility.

PRINCIPAL EQUIPMENT

Turbine generator	Westinghouse Electric Corp.
Primary switchgear	Westinghouse Electric Corp.
Transformer (feeder from utility)	Westinghouse Electric Corp.
Steam generators	Erie City Iron Works
Soot blowers	Diamond Power Specialty Corp.
Bi-color water columns	Diamond Power Specialty Corp.
Spreader stokers	Detroit Stoker Co.
Feeder drives	Reeves Pulley Co.
Auxiliary turbine (feeder drive)	Carling Turbine Blower Co.
Grate drives	Reeves Pulley Co.
Speed reducers (grate drives)	Link-Belt Co.
Gas burners	Webster Engineering Co.
Gas burner control valves	Maxon Premix Burner Co.
Combustion controls	Bailey Meter Co.
Boiler instrumentation	Bailey Meter Co.
Oxygen recorders	The Hays Corp.
Air compressors	Ingersoll-Rand Co.
Air compressor motors	General Electric Co.
Forced draft fans	Buffalo Forge Co.
Forced draft fan motors	General Electric Co.
Forced draft fan turbine	Elliott Co.
Induced draft fans	Buffalo Forge Co.
Induced draft fan motors	Wagner Electric Corp.
Induced draft fan turbine	Elliott Co.
Fly ash collector	Western Precipitation Corp.
Overfire air and cinder return system	Detroit Stoker Co.
Overfire air and cinder return fans	Buffalo Forge Co.
Stoker cooling fans	Clarage Fan Co.
Spray-type desuperheaters	Bailey Meter Co.
Pressure reducing valves	Bailey Meter Co.
Horizontal desuperheating pumps	Allis-Chalmers Manufacturing Co.
Vertical desuperheating pumps	Ingersoll-Rand Co.
Coal handling system	Stephens-Adamson Manufacturing Co.
Automatic coal scales	Richardson Scale Co.
Ash handling system	United Conveyor Corp.
Zeolite water softener	The Permutit Co.
Deaerator heater	The Permutit Co.
Chemical feed pumps	Milton Roy Co.
Feedwater pumps	Goulds Pumps, Inc.
Feedwater pump motor	Allis-Chalmers Manufacturing Co.
Feedwater pump turbine	Terry Steam Turbine Co.
Feedwater regulators	Copes-Vulcan Division
Dowtherm vaporizers	Foster Wheeler Corp.
Gas burners (Dowtherm vaporizers)	National Airoil Burner Co.
Consulting Engineers	Pfeifer and Shultz
Prime Contractor	Power Service Corp.
Electrical Contractor	Industrial Electric Co.



Installation photo shows typical arrangement of fully automatic, mixed bed demineralizing units.

Demineralization

. . . A Means to Purer Water

I&P EXCLUSIVE

AN INDUSTRY AND POWER EXTRA BONUS FEATURE

Industry is constantly demanding water of higher and higher purity. Demineralizing systems produce such a water, almost completely free of ionized impurities — a better water for power or process.

JAMES BOYD SMITH
Research Chemical Engineer
The Permutit Company

THE DEMINERALIZING or deionizing process is a method of removing ionized impurities from solution and providing virtually complete purification. Its principal application is in the purification of water, but the procedure also is used in the treatment of other solutions.

Normal water supplies are quite pure by usual chemical standards because most of them contain only small quantities of the common impurities (Table 1). For example, the U. S. Public Health Service recommends a maximum of 500-ppm (0.05-percent) total solids in drinking waters *(17)*,* and most supplies are well within this value *(49)*. Even limited amounts of certain impurities, however, can cause serious difficulties such as scale formation by hardness or discoloration of products by iron or manganese.

While numerous methods are available for removing specific impurities, such as deaeration for oxygen removal and zeolite or lime soda softening for hardness removal, the only commercially practiced processes for completely purifying water are distillation and demineralization. Each has its general field of application. Demineralizing is less expensive for fresh water, but distillation becomes relatively cheaper as the salinity increases. Distillation will remove nonvolatile, nonionized impurities which are occasionally present in small amounts in water supplies. Demineralization will not remove completely nonionized substances although it will remove such weakly ionized materials as silicic acid and also will provide a more complete removal of electrolytes than will distillation. Effluents with as low as 0.003-ppm (0.0000003-percent) electrolytes have been produced from water by mixed bed demineralizing *(22, 72)*.

Principles of Operation

Basically, any demineralizing system depends on the process of exchanging ions in solution for those on some solid ion exchange material *(77)*. Various types of chemical exchangers are used, but all of them are in the form of small insoluble granules or beads with ionized groups (associated with mobile ions of opposite charge) fixed in their structure. Cation exchangers, for example, contain negatively charged groups and might be thought of as a large insoluble multivalent anion. The cations associated with the groups are free to ionize and exchange for others.

The most familiar type of ion exchange is zeolite softening, which uses cation exchangers to exchange sodium ions for the calcium and magnesium ions in the water. This

*Numbers refer to bibliography, page 72

TABLE 1 — IMPURITIES GENERALLY PRESENT IN WATER SUPPLIES

Cations

Calcium and Magnesium Cations — Usually present. These are the water hardness cations and can cause trouble by forming scale or precipitates.

Sodium and Potassium Cations — Usually present. Not generally as troublesome as hardness.

Iron and Manganese — Frequently present, but generally only up to a few parts per million. Iron is more common, usually in the form of insoluble hydroxide. Both can cause trouble by forming sludges which stain or discolor, or other undesirable compounds.

Ammonium Cation — Sometimes present, usually only a few parts per million. Source is usually pollution.

Aluminum — Infrequently present, usually as aluminate anion or insoluble aluminum hydroxide.

Heavy Metals such as Copper, Zinc, or Lead — Infrequently present and then usually from contamination of supply with waste water. Even in small concentrations they can cause a number of troubles.

Anions

Chloride Anion — Usually present.

Sulfate Anion — Usually present.

Nitrate Anion — Sometimes present, usually to the extent of only a few parts per million.

Phosphate Anion — Seldom present in natural water but is sometimes added to treated supplies.

Carbonate Anion, Bicarbonate Anion, and Free Carbon Dioxide — Usually present. Carbonates and bicarbonates constitute water "alkalinity". The ratio of these three impurities depends on the pH of the water.

Fluoride Anion — Occasionally present to the extent of a few ppm in natural waters. About 1 ppm is being added to a number of water supplies to prevent dental cavities in children.

Silica — Usually present in amounts up to approximately 25 ppm.

Miscellaneous

Hydrogen Sulfide (sulfides) — Found in water in some areas up to a few ppm.

Methane Gas — Present in a few well waters.

Oxygen and Nitrogen — Present in water that has contacted air.

Turbidity — Suspended matter of any sort is termed "turbidity".

Color — Color may be developed when organic matter, such as humic acid, is leached from vegetable matter. Iron and manganese also can cause color.

Organic Matter — May be derived from vegetable matter leached by the water or may come from pollution by sewage or waste waters. Organic matter can range from humic acids to proteinaceous materials or materials such as detergents.

Methods of analysis for water impurities are available in the literature (43, 68).

reaction, with Z representing the cation exchanger or zeolite, is:

$$Na_2Z + \begin{matrix}Ca\\Mg\end{matrix}\left\{\begin{matrix}Cl_2\\SO_4\\(HCO_3)_2\end{matrix}\right. \rightleftharpoons \begin{matrix}Ca\\Mg\end{matrix}\left\{Z + Na_2\right\}\begin{matrix}Cl_2\\SO_4\\(HCO_3)_2\end{matrix}$$

Similar reactions can, of course, be carried out with other than sodium ions; for example, the cation exchanger might contain hydrogen ions. If so, the acids corresponding to the salt impurities are formed.

It should be noted that the reaction represents a mobile equilibrium which can be made to go in either direction. Thus, if a definite amount of cation exchanger containing hydrogen ions is equilibrated with a definite amount of solution containing, for example, sodium chloride, the sodium and hydrogen ions will be distributed in both the solution and ion exchange phases. The concentrations of each in each phase will be governed by some such relationship as:

$$\left\{\frac{\text{Conc. } Na^+}{\text{Conc. } H^+}\right\}\text{in Exchanger} = K \times \left\{\frac{\text{Conc. } Na^+}{\text{Conc. } H^+}\right\}\text{in Sol.}$$

where K is a constant dependent on the ions, the exchanger, solution, concentrations, and other variables. This is merely an expression of the mass action law *(38, 48)*. Other more exact relationships and the chemical kinetics of the reactions can be found in a number of texts and papers *(9, 20, 38, 48)*.

Although a definite equilibrium will exist at any selected point in the demineralizing unit, the relationship between the sodium and hydrogen ion contents of both the bed and the water changes constantly. As the water flows through the column and contacts fresh exchange material, each new equilibrium value will show a reduced amount of sodium in the water and more in the bed. Eventually the water will be essentially free of sodium and will contain only hydrogen ions.

Anion exchange involves exactly the same principles and analogous relationships apply. The difference is in the structure of the bed materials, which contain positively charged ionized groups that can exchange negatively charged anions. If these materials are saturated with hydroxyl anion, the reaction, with RN representing the anion exchanger, for treating waters containing acids is as follows:

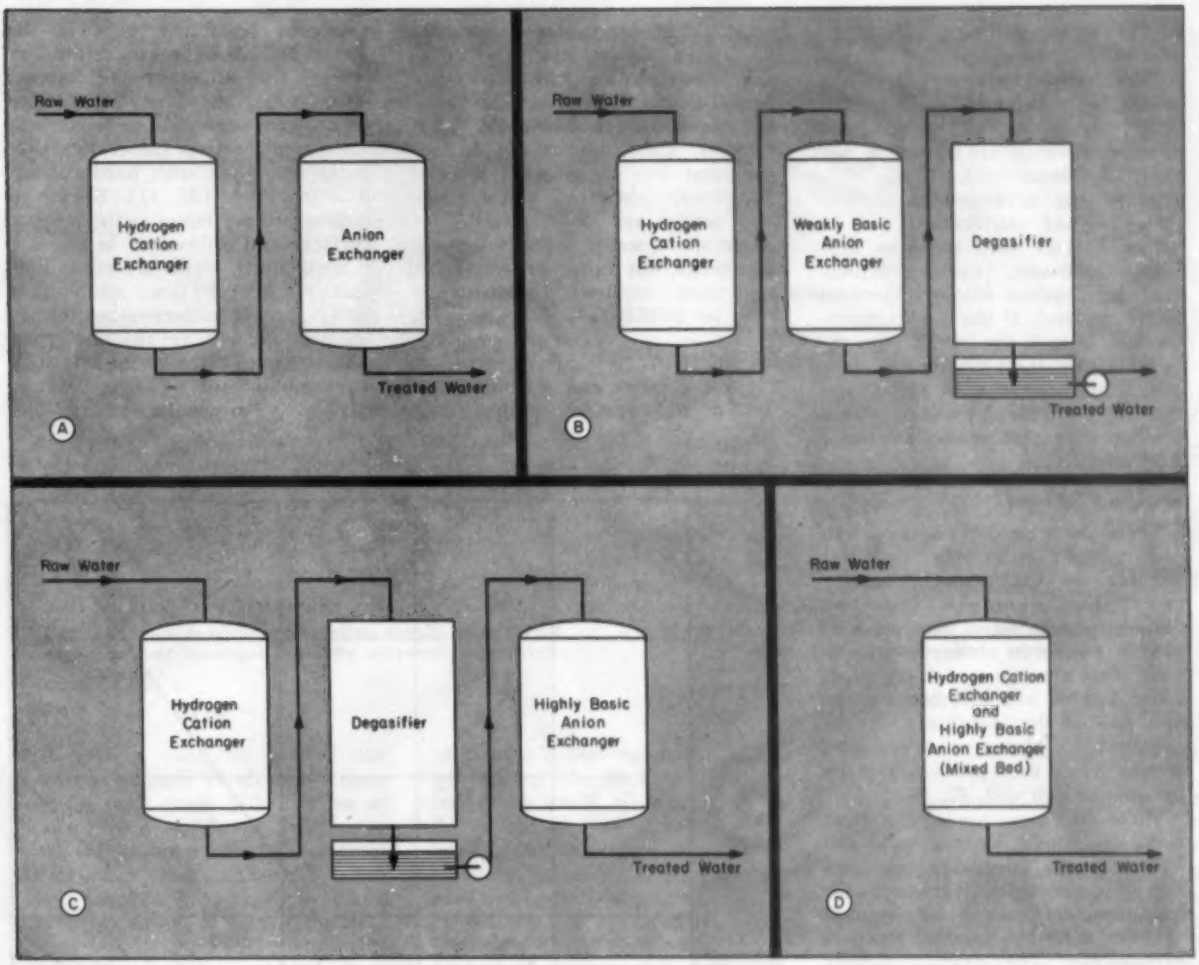
$$2RNOH + H_2\begin{Bmatrix}Cl_2\\SO_4\\(HCO_3)_2\end{Bmatrix} \rightleftharpoons (RN)_2\begin{Bmatrix}Cl_2\\SO_4\\(HCO_3)_2\end{Bmatrix} + 2\,H_2O$$

With acids in the water, the reaction is forced to the right by the formation of nonionized water. If salts were present, the same equation would apply, but the corresponding hydroxides would be formed. Similarly, chlorides would be formed when using an anion exchanger saturated with chloride.

Since the exchange materials do not have an unlimited capacity, after a time the ions will all be exchanged. The reaction then is reversed by passing a strong solution containing the desired ion through the bed. This process is called regeneration. In demineralizing, an acid solution is used for the cation exchanger and an alkali, such as sodium hydroxide, for the anion exchanger. These weak solutions reverse the equilibrium, replacing the desired ion on the exchanger. The higher ionic strength of the regenerant often changes the constant K in the equilibrium formula, which may assist the regeneration of the exchangers.

Types of Processes

All cation exchangers currently used in demineralizing systems contain strongly ionized groups and will exchange all cations present in the solution. Anion exchangers are, however, of two general types: those that are strongly ionized (termed highly basic), and those that are not (termed weakly basic). The former type will, like cation exchangers, exchange all anions present in the water, but weakly basic materials will exchange only strongly ionized anions such as



Basic demineralizing system arrangements include: (A) two-step without degasification; (B) two-step weakly basic anion exchange with degasification; (C) two-step highly basic anion exchange with intermediate degasification; (D) mixed bed.

chloride or sulfate, but not weakly ionized ones, such as carbon dioxide or silica.

Project conditions will dictate the exact equipment selection, but in its simplest form, demineralization consists of passing water or the solution to be purified through a cation exchanger on the hydrogen cycle followed by a weakly basic anion exchanger on the hydroxyl cycle. This two-step arrangement successively converts the salt impurities in solution into acids and then into water, and removes all ionized solids except silica and CO_2.

Degasification

If carbon dioxide is objectionable, it may be removed by passing the effluent through a decarbonation tank, degasifier, or vacuum deaerator. A degasifier is a tower or tank containing wood slats or some type of packing such as Raschig Ring that will break up and distribute the water flowing down through the unit. Meanwhile, air supplied by a blower at the bottom of the tower flows upward, strips the carbon dioxide from the water, and exhausts at the top. Decarbonation tanks are similar in function and flow direction, but do not contain packing. The carbon dioxide is removed by bubbling air through the liquid. Vacuum deaerator tanks also are packed with slats or rings, but the dissolved gases (oxygen, nitrogen, and carbon dioxide) are removed by a vacuum produced by a steam jet ejector or a pump.

Where silica removal is important, a highly basic anion exchanger must be used. The system arrangement, however, requires careful study because the highly basic anion exchanger will remove carbon dioxide as well as silica and the strong acid anions, and frequently it is less expensive to remove the CO_2 by degasification. The sodium hydroxide required to regenerate the carbon dioxide out of the anion exchanger is relatively expensive when compared to the small amount of power needed to operate the degasifier blower. Therefore, a degasifier is usually placed before the anion exchange unit, except on small installations or unless the carbon dioxide and bicarbonates (which are converted

to CO_2 in the hydrogen cation exchange unit) are low.

The last basic system utilizes the mixed bed demineralizer. With this unit, the cation and highly basic anion exchangers are mixed together in the same tank. The advantage of the arrangement is that even higher purification can be achieved than with two-step systems. Generally, two-step demineralizing provides 90- to 99-percent solids removal. If the ion exchangers are mixed, the result is comparable to a large number of two-step units operating in series, and the water produced contains only a fraction of a part per million residual impurities.

Modified Systems

These basic processes also can be combined in various ways depending on the project requirements. For example, four-bed systems, consisting of two pairs of two-step units in series, have been used. This arrangement gives purer water and at less cost because the first pair of demineralizers can be operated to a higher solids endpoint of run when they are followed by the second pair *(19, 42, 58)*.

Three-step processes, including cation exchange, weakly basic anion exchange, degasification, and highly basic anion exchange for silica removal, have been proposed *(24, 49)*. With this method, the less expensively regenerated weakly basic anion exchanger carries the main anion removal load, and for some conditions, the used regenerant from the highly basic unit could be used as a regenerant for the weakly basic exchanger *(62)*.

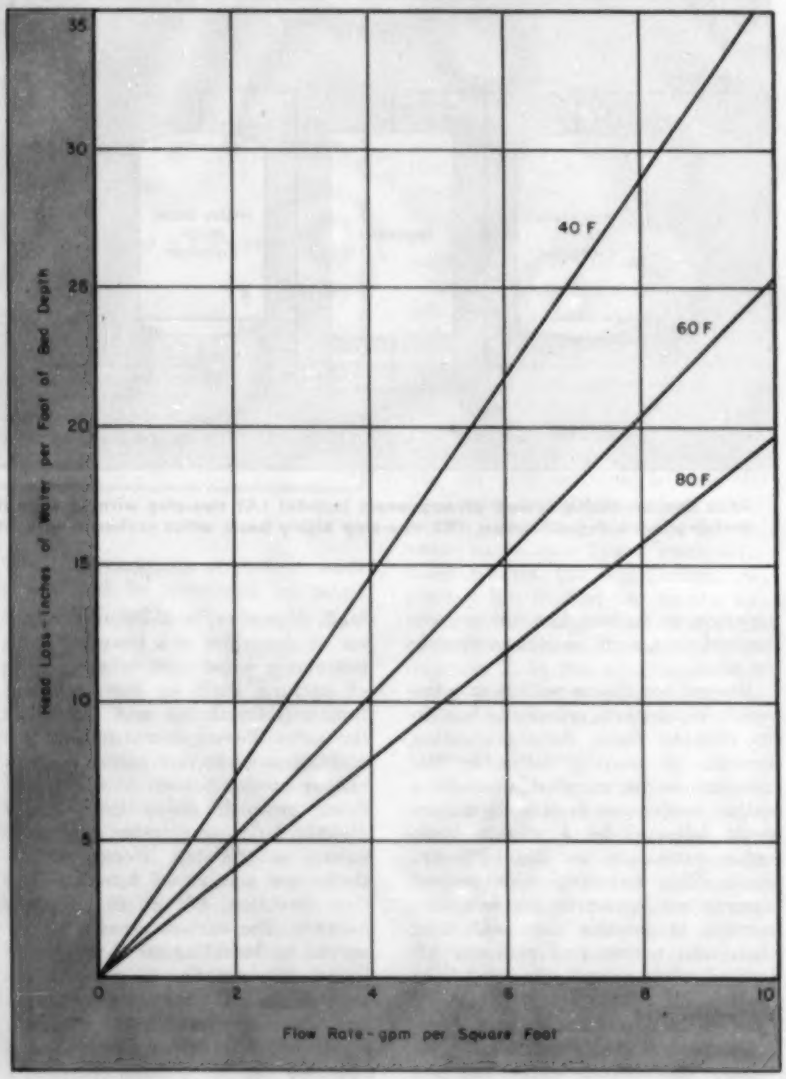
For waters with high solids contents, complex systems have been evolved in which multiple sets of units are operated to give a countercurrent effect of regenerant and water flows, thereby increasing the efficiency and economy *(67)*. In installations treating large flow rates, a number of hydrogen cation units can be operated in parallel and discharged into a single header. The header in turn will feed a number of anion exchange units in parallel *(12, 81)*. This arrangement is flexible and provides uniform flow rates even when one or more units are off the line for regeneration.

Most demineralizing systems are operated as pressure processes although sometimes gravity flow is employed in large plants. Pressure units are almost always vertical cylindrical tanks with outwardly dished heads (except in a few special instances) in diameters up to 11 feet, since this is the largest size that can be shipped by rail completely fabricated. Usual pressure ratings are 75 or 100 psig because most water systems are in this range, but higher pressures are sometimes required. Design codes such as ASME *(59)* may be used.

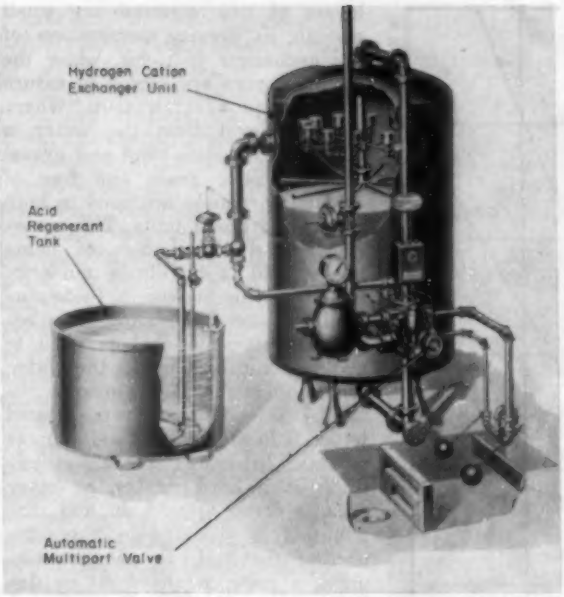
Equipment Design

Since alkalies and acid are used during regeneration and acid is produced from the salts in the water by the hydrogen cation exchange run, all tanks and internal parts must be either constructed of resistant materials or lined with a resistant coating. Generally, large tanks are lined with hard rubber, 3/16-in. thick *(65, 81)*. Sheets of rubber are cemented to the interior surfaces and vulcanized in place.

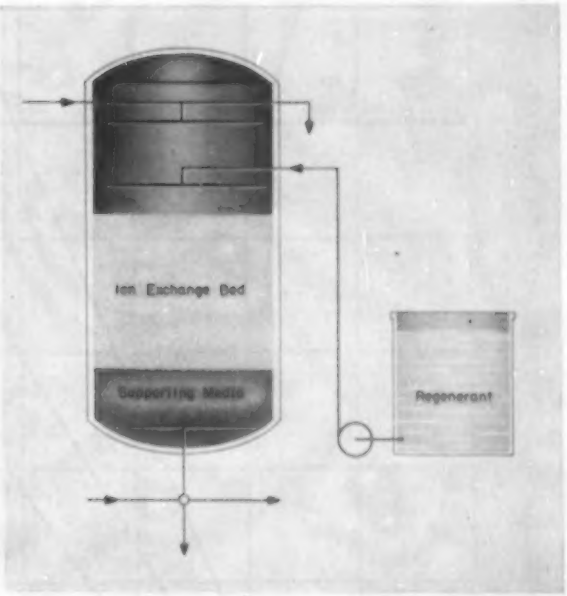
Small units, which are more difficult to rubber line, often have spray-applied protective coatings of the phenolic or vinyl chloride types. Such coatings must be thick enough (a minimum of 0.005 inches) to completely protect the steel, and



Head loss through typical resin bed at various flow rates and temperatures.



Cutaway view reveals construction details of a cation exchange unit arranged for fully automatic operation.



Sectional view illustrates the relative locations of internal parts, ion exchange bed, supporting media.

the coating must be carried out over the flanges of all connections in the tank shell. Other types of linings such as Saran rubber or coal tar bitumen have occasionally been used, and tanks also have been fabricated of resistant alloys such as Monel. For gravity systems, wood stave tanks or concrete basins adequately protected from corrosion by coatings are used *(65)*.

Flow Distribution

One prime consideration in the design of demineralizing units is providing even and well distributed flow through the bed of exchange materials, which occupy the lower part of the tank. Thus, essentially all units are operated downflow during the run or exhaustion cycle *(48, 49)* because it is difficult to obtain proper distribution and to prevent channeling with upflow operation. In addition, the tanks must be vertical or else the bed will tend to shift to the low side and will not be uniform in depth. Tanks generally are supported on jack-type legs to assist in leveling.

Tank height is important. Depending on the bed material (anion exchangers are lighter than cation exchangers and tend to expand more at a given flow rate), from 50 to 100-percent free space must be available for expansion of the bed during the backwashing. The bed depth itself is limited only by the height of tank (based on the head room restrictions of the project), but generally it does not exceed five or six feet, and a minimum of two feet is required to assure good flow distribution and adequate contact of the water with the exchanger. Flow rates are governed mainly by hydraulic considerations, but rates up to as high as 8 to 10 gpm per square foot of bed area are being used. However, if flow rates are too high, excessive pressure loss through the ion exchanger and packing of the bed may result.

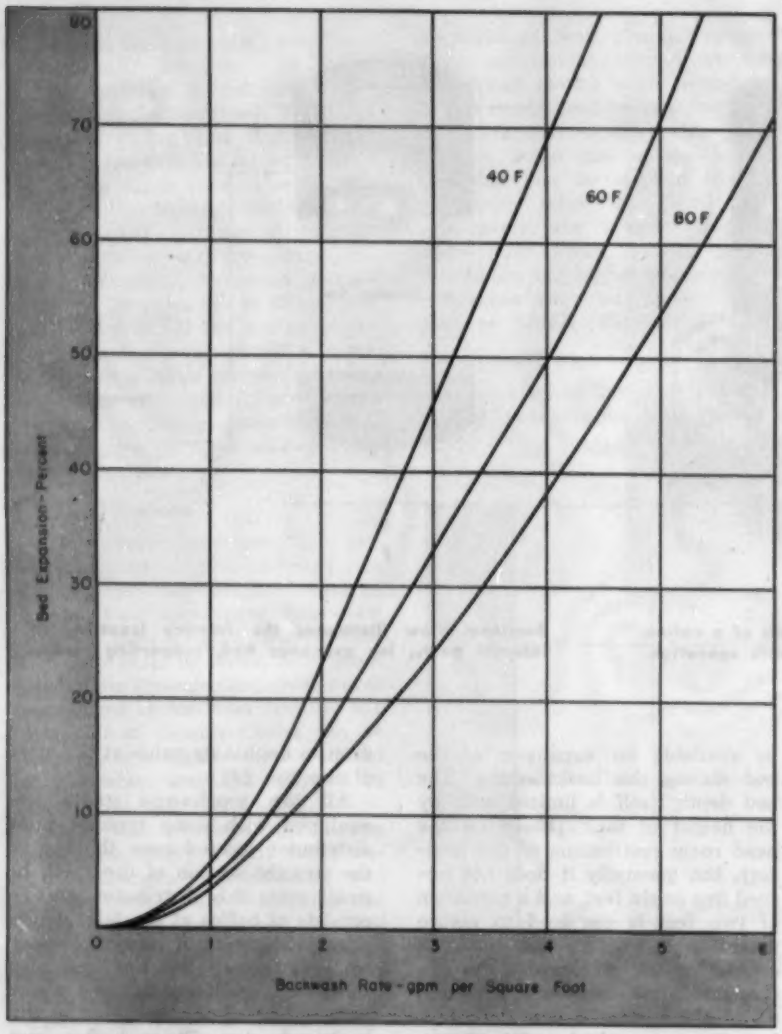
Pressure Loss

Pressure loss through ion exchange units usually approximates a few pounds per square inch, of which the bed contributes in the range of one to two feet head loss at normal flow rates of 6 to 8 gpm per square foot of bed area. Both temperature and particle size have a significant effect on pressure drop as shown in the pressure drop curve of a typical exchange resin. The pressure drop through the ion exchanger frequently will increase as the run proceeds. Filtering out of a small unavoidable amount of dirt on the bed may raise the pressure drop to double its value at the start of the run *(70)*.

All ion exchange units are equipped with some type of inlet distributor located near the top of the straight section of the shell. In small units this distributor usually consists of baffles at the inlet which prevent currents of incoming water from disrupting the bed and also serve as a collector for the water passing out of the unit during the backwash step. These baffles may be of brass or hard rubber.

In large units, baffles do not provide adequate distribution for either inflow or backwashing. Therefore, distributor spiders with drilled orifice holes which give even flow over the entire area or header-lateral arrangements with inlet diffusers are employed. Inlet diffusers are cylindrical devices, perforated in the side, that spray the water sideways and give uniform distribution over the bed. The distributor pipes are generally brass for hydrogen cation exchange units and either a polymer such as a rubber derivative on a rigid vinyl chloride or an acid resistant alloy such as stainless steel for anion exchangers.

Ion exchange beds usually are supported on an underfill of a granular material such as silica gravel or anthracite coal. The upper



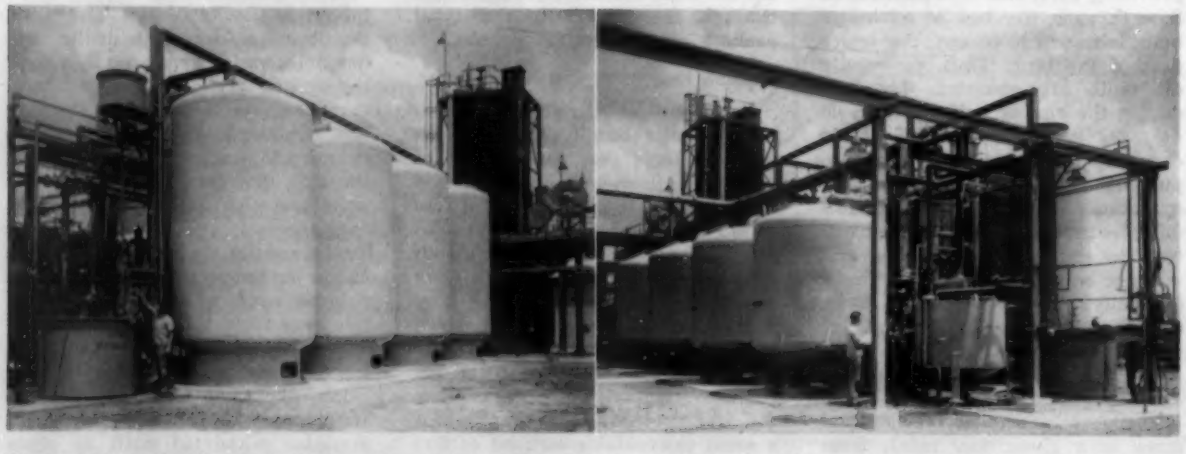
Expansion of typical cation bed at various backwash flows and temperatures.

layers of this material are small enough to prevent penetration of the exchanger particles, while the bottom layers are larger to assure proper flow distribution. Where silica removal from the water is not a factor, silica sand and gravel of the proper grade and free of calcium carbonate are used in both cation and anion units. This material has the advantage of being heavy, and it has little tendency to shift during backwash. In demineralizing plants providing silica removal, anthracite coal is used to avoid pickup of silica in the water, especially in the anion units.

The outlet collector for the treated water is located in the bed support medium. In small units this underdrain is a hard rubber or other organic composition hub, and distribution is provided by the supporting material. In medium-size units, a baffle arrangement or deflector plate of rubber covered steel is used which lies close enough to the bottom head so the gravel cannot get underneath it but is evenly spaced away from the head to assure uniform flow around its circumference. Large units require spiders or header-lateral collectors, fabricated of pipe made from hard rubber, rubber derivatives, or inflexible vinyl chloride polymers. Corrosion resistant alloys also may be used. Again, the collector must be provided with drilled orifice holes, properly sized and spaced.

Backwashing

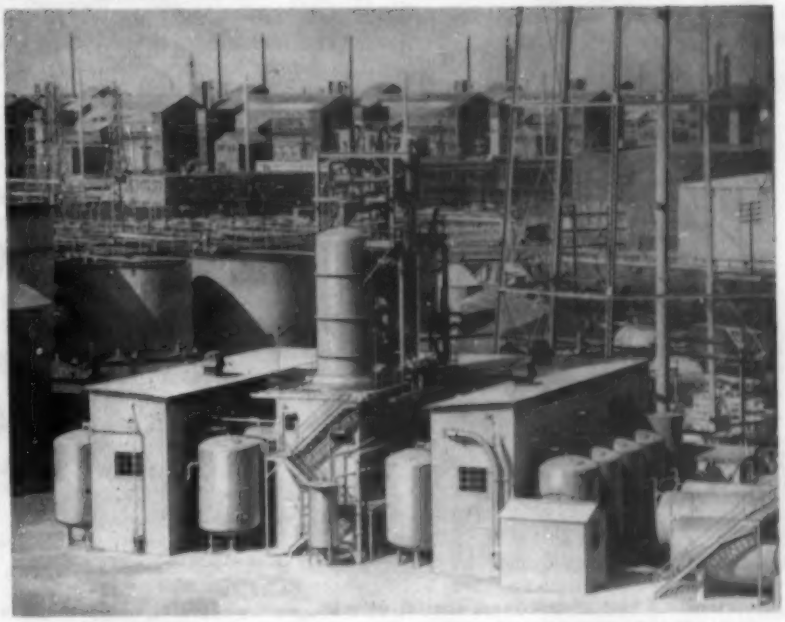
When the exchange material is exhausted after an operating run,



These photographs show a large, two-step, highly basic anion exchange demineralizing system with intermediate degasifier.

the first step in restoring capacity is backwashing. This procedure consists of passing water upflow through the unit to expand, fluidize, loosen, and regrade the bed and prevent channeling of the flow during the next operating cycle. It also washes out any dirt that may have been filtered out by the bed. With mixed bed units, backwashing serves the added purpose of separating the anion and cation exchange resins, which have different densities, for regeneration.

Flow distribution is especially important in backwashing, since the bed should be evenly expanded, and the gravel or anthracite coal support layers must not be upset or mixed with the ion exchanger. Fortunately, the backwash flow rates that produce the proper expansion (50 to 100 percent) are the same order of magnitude as the downflow run exhaustion flow rates, ranging from one gallon per minute per square foot of bed area for some types of anion exchangers to 6 to 10 for some of the cation exchangers. Temperature effects backwash flow rates (see illustration), and this minimizes distribution problems. Backwash time is about 5 to 10 minutes or until the outlet water is essentially clear.



Systems serving utility plants often have vacuum deaerators for CO_2 removal.

Regeneration

Following the backwash step, exchange capacity is restored by passing regenerating solution down through the bed. These regenerant chemicals usually are prepared in separate dilution tanks. For cation exchangers, water is placed in the dilution tank, and then a measured amount of sulfuric acid (most frequently 66° Bé technical grade) is added. On small installations, the acid can be measured in portable containers or stationary tanks. Large plants, however, utilize some type of system involving a metering pump or employ vacuum to draw the acid into a measuring tank *(55)*, from which point it is automatically dumped into the dilution tank. The dilution tank can be a ceramic crock for small units, or a lead or rubber lined tank for large units. Small units are agitated by hand with a paddle, while large units are equipped with an air grid or mechanical agitator.

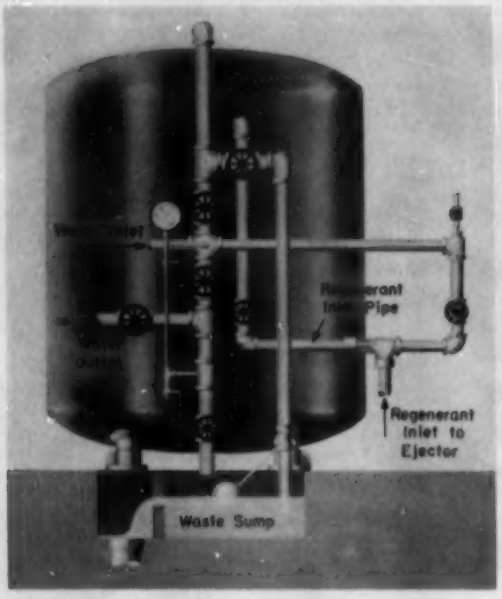
Weakly basic anion exchangers are regenerated with soda ash, which is almost always supplied in bags. A measured amount of the soda ash is dumped into a dilution tank (generally constructed of steel) and then it is dissolved in water. Agitation, by hand for small units or with a high-speed impeller mixer for large units, is required because even the so-called "light soda ash" dissolves a bit more slowly than, for example, caustic soda.

Caustic soda (NaOH) is used to regenerate strong base anion exchangers and, in some instances, weak base anion units. This material is supplied as a flake chemical, shipped in drums, or as a 50-percent solution. On large installations the use of liquid caustic may be justified and, if so, it is stored in steel tanks and then measured into the dilution tank. Most plants, however, utilize the flake caustic and prepare the regenerant solution by the same general procedures used for soda ash. For large units, the flake is placed in a dissolving basket (a smaller tank with a perforated bottom) mounted above the dilution tank. Water enters at the top and dissolves the caustic soda as it passes through the basket.

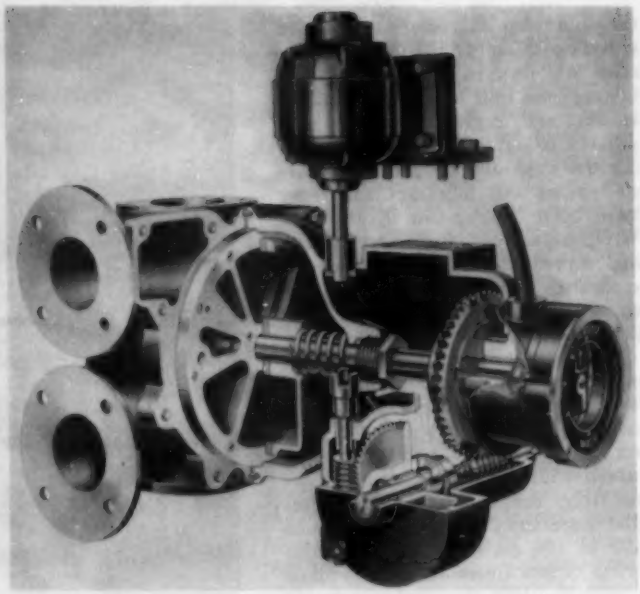
Regenerant solutions usually are transferred from the dilution tank to the ion exchange unit by water operated ejectors. The pressure water to the ejector serves not only to suck up the regenerant solution, but also to further dilute it to the proper concentration. Both the water flow rate to the ejector and the chemical flow rate from the dilution tank are adjusted by set cocks. Various means, such as rotameters, can be used to indicate the proper rates. Under some conditions, the regenerant can be prepared in the exact dilution required and then pumped into the exchanger, or concentrated regenerant may be pumped directly by metering pump into a stream of water flowing into the unit. With the latter arrangement, proper precautions must be taken to avoid the danger of water flowing back into the concentrated regenerant, especially if it is concentrated sulfuric acid.

Ejectors are generally bronze, although alkali ejectors are occasionally iron and acid ejectors may be plastic or corrosion resistant alloys. Regenerant piping is constructed of similar materials, but rubber lined steel pipe, or Saran and other plastic types also can be used for acid regenerants. The acid regenerant piping and ejector should be backflushed after regeneration to prevent corrosion.

In some instances, more complex regenerant systems utilizing increased acid strengths or sodium chloride preceding the acid are used. The principles are generally similar. Furthermore, highly basic



Unit with a nest of individual control valves.



Special multiport valve for controlling exchanger operations.

anion exchangers frequently are regenerated with warm caustic soda solution (95 to 130 F).

Uniform flow over the entire bed of the exchanger is again important during regeneration. A separate distributor usually is employed although in small units the inlet distributor will suffice. Separate distributors are placed a few inches above the bed, since this location has been found to provide the best distribution of the regenerant *(50)*. The distributor must be corrosion resistant and strong enough so it will not be broken during the backwash. Bronze, stainless steel, or plastic pipe header-laterals or spider grids are installed in large units. Small ones have a distributor hub.

Rinse

After regeneration, the undesirable ions, which have been replaced, and the excess regenerant solution must be removed by rinsing the bed of the exchanger. This rinse step may be preceded by a so-called slow rinse at a flow rate approximating the regenerant introduction rate to allow proper contact time. However, the final rinse is carried out downflow with normal influent water from the upper inlet distributor, at a rate approximating the design flow rate, until the effluent water is of the proper quality. Rinse volumes are from 20 to 50 times the bed volume for cation exchangers and from 50 to 150 for highly basic anion exchangers.

Some plants can improve the economy of operation by reusing a portion of the regenerant (rinsed from the unit toward the end of the cycle when the least amount of contaminating ions are present) for the first part of the subsequent regeneration. This solution is directed to a storage tank and then pumped through the unit on the next regeneration before the fresh chemical is introduced. The economics of such a system must be weighed carefully, and it must be realized that difficulties are sometimes experienced with such conditions as calcium sulfate precipitation in reclaimed sulfuric acid regenerants *(24, 27, 28, 62, 67)*.

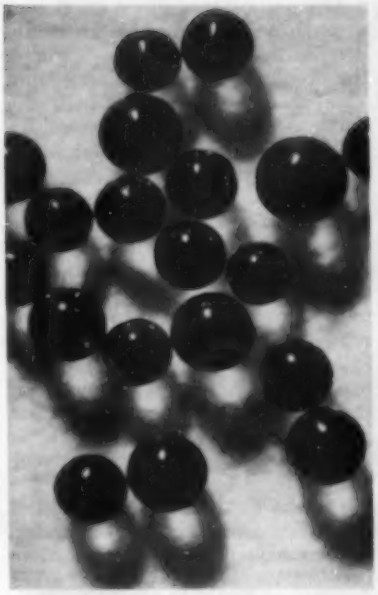
Recycling of anion rinse effluents also may be employed to save water. With this arrangement, the rinse effluent from the anion unit is recycled by a pump to the inlet of the cation unit after its total dissolved solids content reaches the level of the raw water. Thus, extra rinse water plus capacity of the ion exchanger units are saved although an extra pump and some piping are required *(57, 75)*.

Piping and Valves

Valve arrangements and piping are important parts of any demineralizing installation. Inlet piping to the cation unit can be of any normal type since only raw water is handled. The remainder of the external interconnecting piping, however, should be corrosion resistant since it will carry the acid, hydrogen cation treated water, or the pure demineralized water which must not be contaminated. Piping up to one or two inches can be Saran, some rubber derivative or similar plastic type, or stainless steel. Larger piping is usually rubber lined, flanged type, and must be fabricated from careful layout drawings because most types cannot be cut in the field *(31, 65)*.

Multiport valves often are favored for demineralizing plants because they can control a number of flows during the various cycles. Advantages include simplicity and ease of operation plus reduction in the chances for human error when compared to nests of single valves. Satisfactory service also is obtained with rubber or plastic lined diaphragm valves and globe, gate, or plug valves of corrosion resistant materials. Larger plants may employ hydraulically or pneumatically operated valves controlled from a central station.

The illustrated multiport valve, designed specifically for ion exchange units, employs two sliding plates that contain ports to direct



Sulfonated polystyrene cation resin.

flows in various directions *(11, 54)*. The plates are rotated relative to each other to change flows during the different operations. This valve requires little maintenance and has good pressure loss characteristics. Other types of valves include the lift-turn type, in which the two plates are lifted apart before rotation, and the poppet type, which has a number of poppets operated mechanically or hydraulically by a pilot valve.

Since it is necessary to know the total flow of water through the exchange units between regenerations, a water meter should be installed on the inlet to the cation exchange units and perhaps on the outlet of the anion units. These meters may be disc or turbine type or flow recorders with totalizers. They can be arranged to sound alarms or actuate the regeneration cycle on automatic installations after a predetermined operating run.

Flows during various operations such as the backwash or rinse steps must be controlled at proper rates. Devices such as orifices, set valves, or rotameters plus throttle valves can be used. An excellent arrangement is a butterfly valve controlling the volume in accordance with the flow of water over an orifice board or weir *(4)*. Flow rates during the run or exhaustion cycle are controlled by set valves, which may be used in conjunction with hydraulically, pneumatically, or solenoid operated valves to turn the units on or off according to the demand.

Types of Cation Exchangers

Cation and anion exchanger materials are of many types *(38, 48)*. Those useful in demineralizing must be resistant to acids and hence are organic in nature. These materials as well as the demineralizing process were developed in the 1930's *(1, 3, 8, 44, 76)*.

At present, one of the most widely used cation exchangers is the sulfonated styrene type. Examples are Amberlite IR-120, Dowex 50, and Permutit Q. Beads of polystyrene are prepared by suspension polymerization of styrene to which a few percent of some type of cross-linking agent such as divinyl benzene has been added to make the resultant materials insoluble. The process is carried out by dispersing the styrene in water in a kettle in such a way that it forms drops of proper size. These drops polymerize and harden, and then they are dried and sulfonated by a suitable agent to introduce strongly acidic sulfonic groups throughout the beads *(16, 53)*. The sulfonic acid groups can ionize just as any salt and will exchange cations at all pH values.

Ion exchanger beads are roughly 26 to 30 mesh U. S. Standard (0.033 to 0.012-in. diameter), which has been found to be the optimum size range both from the viewpoint of hydraulic and chemical considerations. The rate of exchange is controlled in dilute solutions by diffusion of ions through the actual particles and, therefore, they should be as small as possible to facilitate this reaction. On the other hand, if they are too small, the water will not flow through the bed properly.

Another type of cation exchanger widely used in demineralizing is the sulfonated coal type, an example of which is Zeo-Karb. This material is produced by sulfonating granules of the proper type of bituminous coal. The resulting exchanger (in addition to sulfonic groups) contains carboxylic groups, which also can exchange cations. The carboxylic group is similar to a weak acid and ionizes only above a pH of about four, associating only with hydrogen ions in the lower range *(3, 75)*.

Various other cation exchangers can be made including sulfonated phenolformaldehyde resins and resins containing only carboxylic or phosphoric groups *(6)*.

Cation Exchanger Characteristics

While capacity is the principal consideration when preparing exchange materials because it determines the amount of water that can be treated before regeneration is necessary, other factors such as chemical characteristics and efficiency are also important. The total capacity of all the exchange groups (called the ultimate capacity) of the sulfonated polystyrene exchangers is around 2¼-gram equivalents per liter of exchanger, or in more familiar engineering terms, 50 kilograins as $CaCO_3$ per cubic foot. Sulfonated coal resins have an ultimate capacity of approximately 13 kilograins, and sulfonated phenolics are intermediate between the two. Actually, these capacities are never fully utilized for several reasons. First, an uneconomically large amount of regenerant solution would be required. Second, as the bed approaches exhaustion the metal ions from the untreated water will "break through" because of slightly uneven flow, rate of exchange considerations, and other factors *(78)*.

In practice, the maximum capacities obtained with polystyrene sulfonate are about 20 to 30 kilograins per cubic foot with approximately 10 to 15 pounds of acid at 10 to 15-percent concentration. This amount is about two or three times the theoretical amount of regenerant, which is the excess of acid that must be used to drive the regeneration to completion *(7, 27, 36)*.

The sulfonated coals produce an operating capacity of around 7 to 8 kilograins per cubic foot using about two pounds of two-percent acid, which is more efficient. This capacity varies with the analysis of the water, being lower on waters with low amounts of alkalinity *(3, 75)*.

Sulfuric or hydrochloric acids generally are utilized for regeneration. Sulfuric acid is cheaper, but the 10-percent strength cannot be used directly in exchangers that have treated water containing calcium, since relatively insoluble calcium sulfate will precipitate and foul the bed *(7, 35, 39)*. Two-percent acid, which does not precipitate calcium sulfate, is satisfactory for sulfonated styrene resins and provides a capacity of about 10 to 15 kilograins with 5 to 10 pounds of acid. The chemical efficiency is the same,

but the capacity is lower. Sulfonate coals are not sensitive to concentration and always are regenerated with two-percent acid.

Various expedients such as stepwise increase in acid strength or pretreatment with sodium chloride solution to remove the calcium have been applied to avoid troubles with calcium sulfate and to permit the use of higher concentrations of cheaper sulfuric acid on styrene base exchangers. These methods provide higher capacities, but the regeneration procedures are more complicated. Sometimes economics or other considerations justify the use of hydrochloric acid, thus avoiding such problems *(25, 39, 74)*.

Capacity also is influenced to some extent by the influent water analysis. For example, cation exchangers produce higher capacities on waters containing substantial amounts of bicarbonate anion. Carbonic acid (carbon dioxide), which is formed from the bicarbonates, is so weakly ionized that the chemical equilibrium is quite favorable. This is mostly noticeable in the sulfonated coals *(7, 39, 70, 74)*.

Some plants experience difficulties with leakage, which is the passage of metallic cations through a demineralizer bed without being exchanged. Sodium ions (unless the content in the raw water is very low) are the common offender because they are less strongly held by the exchanger than the calcium, magnesium, and other divalent or heavier ions. Conversely, it is difficult to remove sodium in the regeneration step because of a change in the equilibrium constant, K, at the usual higher concentrations. Leakage is, of course, undesirable since the cations will pass through the anion unit *(25, 27, 35, 48, 73)*.

When sulfonated styrene resins are concerned, higher concentrations of acid (applied step-wise if necessary to avoid calcium sulfate) are helpful in reducing leakage (27, 39). Upflow regeneration to provide better restoration of the bottom of the bed also has been proposed *(35)*, but distribution and channeling problems have limited its use in practice. In mixed bed demineralizing upflow regeneration has no theoretical advantage since the bed is mixed after regeneration.

With any demineralizing system, the influent water should be free of suspended dirt and other undissolved foreign matter. Generally it is desirable to limit the turbidity to about 5 parts per million to prevent fouling of the bed. In addition, chlorine (not chloride anion), used to sterilize water, is detrimental to sulfonated coal or phenolic types of exchangers and should be removed by feeding sulfite or by using activated carbon *(10)*. Styrene types are not affected. Sometimes the exchange bed will accumulate bacteria brought in by the raw water. These can be destroyed by various reagents such as caustic soda, hypochlorites (for styrene types of exchangers), formaldehyde, or other materials, if they are not killed by the acid regenerant *(15, 33)*.

The stability of cation exchangers is good and they should last a number of years and treat millions of gallons of water if they are not abused. Additional information is available *(3, 6, 7, 25, 27, 29, 35, 38, 39, 48, 49, 70, 73, 74, 75, 76)*.

Strong Base Anion Exchangers

Anion exchangers are granular or bead materials, roughly the same size as cation exchangers, of two general types: highly basic and weakly basic; but all commercial grades are developed from nitrogen-containing ammonia compounds. Some highly basic types are produced by introducing quaternary ammonium groups into polystyrene beads similar to those used for the sulfonated styrene cation exchangers. The beads are made first and then the quaternary groups are coupled to the benzene rings in the structure. Quaternary ammonium groups, when associated with hydroxyl ions, become a base, comparable in strength to sodium hydroxide, that can exchange weakly or highly ionized anions at any pH.

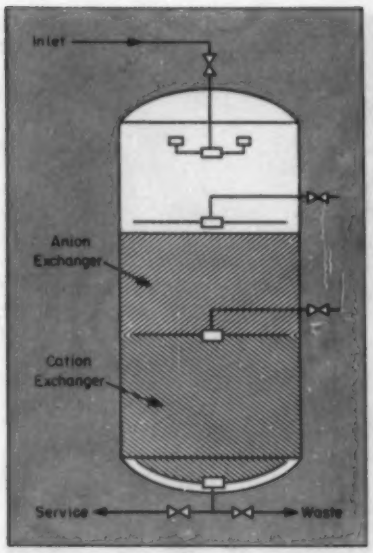
Currently, there are two types of highly basic anion exchangers in general use. Type I has quaternary ammonium groups containing only hydrocarbon groups, for example Amberlite IRA-400, Dowex 1 and Permutit S-1. Type II has some alkanol groups on the quaternary structure as well as hydrocarbon groups, for example Amberlite IRA-410, Dowex 2 and Permutit S-2. Type I resins are slightly more basic and slightly more stable than the Type II. Operating capacities when removing silica average between 10 and 15 kilograins per cubic foot as $CaCO_3$, the Type I resins being at the lower end of this range and the Type II at the upper end *(23, 80)*.

Leakage of strongly ionized ions through anion resin beds is mainly determined by the leakage through the preceding cation exchange unit. This is because the acids in the anion exchanger influent water are converted to nonionized water which fosters a very favorable chemical equilibrium. In fact, the leakage other than silica is principally the sodium hydroxide produced from sodium leakage through the cation unit, even carbonates being removed to less than fractions of a part per million *(12, 57, 66)*. Because of the small unavoidable amount of leakage from the cation unit, however, the effluent from the anion unit usually has a pH value around nine, varying up or down in accordance with various conditions.

Silica is the least strongly held of the anions normally found in water, and consequently it is displaced to the bottom of the bed by other anions as the run proceeds *(51)*. This also accounts for the fact that it is the first impurity to appear in the effluent at the end of the run. Silica leakage has been one of the problems of interest, especially in the use of demineralization to treat power boiler feedwater, since silica is troublesome in high pressure steam generators. Effluent silica leakage will be around 0.01 to 0.2 parts per million depending on the type of exchanger, regeneration procedures, and various other factors.

Highly basic anion exchangers are regenerated with sodium hydroxide solutions of 2 to 5-percent strength, the chemical efficiency of the procedure being such that 3 to 4 times the theoretical dosage is required. Contact time generally averages an hour or more. Anions other than silica are eluted rapidly during the regeneration, but the silica tends to come out more slowly, particularly with the Type II resins. Heating the regenerant to around 100 F or more appears to increase the effectiveness and to speed the removal of the silica. While this technique is especially helpful on Type II resins, it also is used on Type I resins because it reduces silica leakage and improves regeneration efficiency *(12, 23, 27, 51)*.

Higher regenerant dosages give somewhat higher capacities, and have a beneficial effect on silica leakage. A relatively high ratio of other anions to silica in the water to be treated also is favorable. Sodium leakage in the cation ex-



In mixed bed units, the internal parts are arranged to permit separation of the exchange resins for regeneration.

changer does not seem to effect silica leakage, but it may increase the rinse time. Usually, silica leakages are lower with Type I resins than with Type II resins *(2, 22, 27)*.

Since the highly basic anion exchange resins are lower in density than the sulfonated styrene cation exchangers, they must be backwashed at lower rates to prevent losing resin. Flow rates during the run generally approximate 6 gpm per square foot of bed area, the usual minimum bed depth being about two feet. The reaction rate of these exchangers is high, and flow rates could be increased if it were not for possible channeling or other hydraulic difficulties *(40)*.

The stability of highly basic anion exchangers is, in general, not as great as that of cation exchangers. In addition, over a period of time the Type II resins exhibit a loss of power to exchange weakly ionized anions, and to a lesser extent, diminishing capacity to exchange strong anions. It may take years or a large number of runs, but ultimately this loss may amount to 50 percent. Such losses are not as great with Type I resins. However, since their capacity is lower initially, the economics of each must be investigated *(23, 82)*.

Operating capacities also are affected by both sodium content and the ratio of silica to other anions in the influent water, higher ratios of silica giving lower capacities *(23)*. Furthermore, there is indication that contaminants such as iron, aluminates, heavy metals, and some types of dissolved organic matter tend to reduce the quality of operation of these resins. In certain instances replacement of the bed is required although restorative treatments are sometimes effective *(22, 47, 72, 82)*. Dirt, oil, bacteria, and other undesirables must be excluded.

Numerous references list additional information on highly basic anion exchangers *(2, 12, 22, 23, 27, 36, 38, 40, 47, 51, 56, 66, 71, 80, 82)*.

Weak Base Anion Exchangers

Weakly basic types of anion exchangers contain groups equivalent in basicity (ionization constant) to secondary amine groups and will exchange only anions of strong acids such as Cl or SO_4. Examples are De Acidite and Amberlite IR4B. They are generally produced by polymerizing either an aromatic or aliphatic (straight chain) amine with some reactive material such as formaldehyde. The mixture is reacted in a kettle to form a gel, which is then dried and crushed to the proper particle size.

Secondary amine groups are not ionized at higher pH values, and hence anion exchangers relying on them are similar to weak bases such as ammonium hydroxide. They will not exchange weakly acidic anions such as carbonate or silicic acid anions. In fact, there is a difference of opinion as to whether the actual reaction is anion exchange or merely absorption of acids by the amine group, but most evidence appears to favor the first conception.

In demineralizing work, weakly basic anion exchangers can be very efficiently regenerated, only approximately 1½ to 2 times the theoretical amount of regenerant being required. Sodium carbonate, a less expensive alkali than sodium hydroxide, can be used if desired because the reaction is like a neutralization, and the carbonate does not stay on the resins. Exchange capacities are higher than with the strongly basic types, running around 15 to 20 kilograins per cubic foot as $CaCO_3$. However, silica and free CO_2 will be present in the effluent.

Strong acid anion leakage is greater with weakly basic exchangers than with the highly basic types and corresponds more or less to leakage of cations through the cation exchanger. The exchangers are somewhat selective of divalent anions over monovalent ones, and the leakage is usually chloride or bicarbonate. The influent water (flow rates are around 6 gpm per square foot of bed area) should be clean, and not contain heavy metals or free chlorine, which attacks weak base materials.

Regenerant contact times are less for weakly basic resins than for highly basic resins, and rinse volumes are lower because soda ash is more easily rinsed out than sodium hydroxide. Capacities do not vary much with regenerant dosage, and even the use of an amount greater than that required to prevent leakage does not provide an appreciable increase. However, capacities are somewhat dependent on the influent anions, higher capacities being shown with sulfate than chloride.

These materials have the lowest operating cost of any of the anion exchangers used for demineralizing. It must be remembered that the effluent will contain silica, which is not objectionable in many applications, and will have a low pH (4 to 7) due to dissolved carbon dioxide, a few parts per million of which are left even after degasification.

Additional information on weakly basic resins can be found in a number of references *(34, 44, 48, 56, 70, 71, 73, 74, 75)*.

Mixed Bed Demineralizing

Mixed bed demineralization has been recognized as advantageous for a number of years *(52)*. With both cation and anion exchangers mixed together in the same tank, the effect is similar to an extremely large number of alternating cation and anion units. As acid is formed by a cation particle, it is immediately removed by a nearby anion particle and vice versa as the highly basic anion exchangers form hydroxides from salts. Thus, a very favorable chemical equilibrium is produced, giving excellent removal of ions *(18, 22, 37, 47, 56, 72)*.

In order to use the exchangers for more than one run, they must be separated to be regenerated. This procedure was a difficult problem with the resins available during the early stages in the development of mixed bed units. Various flotation and screening arrangements were proposed but were not practical.

Currently, however, it is possible to obtain good separation of quater-

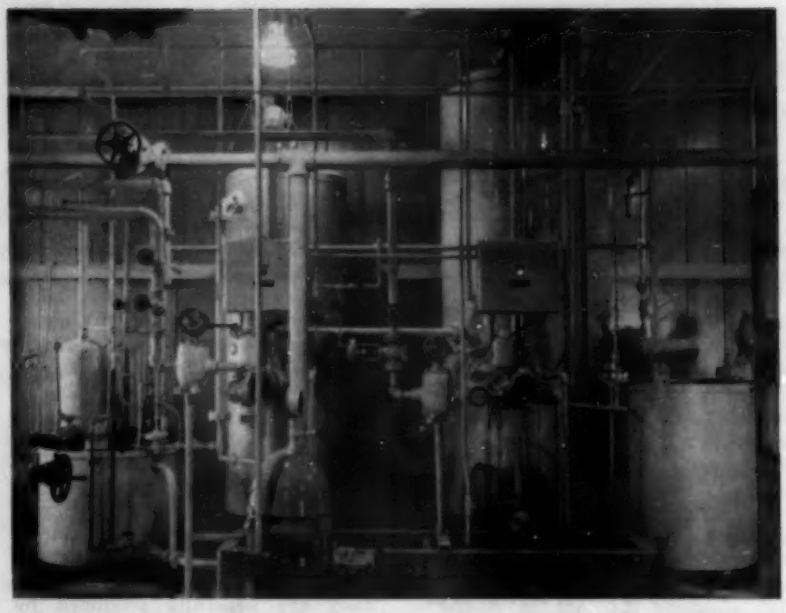
nary ammonium styrene anion exchangers and sulfonated styrene cation exchangers by hydraulic classification. The demineralizing unit is merely backwashed, with the lower density anion exchange materials forming a clean, independent layer on top of the cation resin bed. Once separated, the exchangers can be individually regenerated and then remixed by blowing air through the unit.

Mixed beds composed of various types of weakly or strongly acidic or basic exchangers have been proposed *(37)*, but most units contain sulfonated styrene cation exchangers and quaternary ammonium anion exchangers. The main advantage of such a mixed bed is the extreme purity of the treated water with regards to dissolved electrolytes. Such low concentrations are produced that it is impossible to analyze for the ionic impurities, and the conductivity of the water is used as a measuring guide since even a trace of some ion will have a large effect. The accompanying chart shows the relation between ppm electrolyte impurities, specific resistance of the water, and specific conductance, when the water contains neutral salts. The curve, however, is not correct if the water contains an acid or a base *(18, 22, 37, 56, 72)*.

In some instances water having a specific resistance of over 18-million ohms has been obtained with mixed bed demineralizing units using sulfonated styrene cation exchangers and highly basic anion exchangers. Effluents having 8-million ohms specific resistance or over are common. Such water is so pure that its resistance or pH must be measured by submerged flow cells to prevent contamination by carbon dioxide absorbed from the air. In fact, the resistance can be lowered several million ohms by merely flowing through clean rubber tubes *(72)*.

Silica concentration in the treated water from mixed bed systems, however, does not appear to differ appreciably from the values produced by two-step demineralizing plants using the same types of exchangers. Values of 0.01 to 0.02 ppm were obtained from both mixed bed and two-step units using a highly basic anion exchanger in one experimental study.

Capacities of highly basic anion exchange materials are lower in mixed beds (in some cases as much as 50 percent) than when applied in two-step plants. This effect, in conjunction with the fact that degasification or other mechanical means cannot be used to remove the carbon dioxide produced from raw water alkalinity as in two-step demineralizing, makes the chemical requirements for mixed bed units somewhat higher per unit quantity of water treated *(22, 37)*.



Highly basic demineralizing units remove all anions including CO_2 and silica.

Effluent water quality from mixed bed demineralizers does not appear to be affected by extremely high flow rates (30 to 40 gpm per square foot of bed area), indicating the advantage of the favorable equilibrium conditions. However, it is doubtful if such rates are feasible from a standpoint of hydraulic design, particularly since capacity decreases with increasing flow. In addition, mixed beds contain the relatively low density anion exchangers which must be backwashed at lower rates. They also are more difficult to keep clean and more sensitive to turbidity than two-step systems that have a cation unit first.

In most other respects, ion exchangers in mixed beds show much the same characteristics as in two bed systems. Stability is equivalent, but screen size and density are more important because they affect the separation of the two exchangers. Anion exchangers are more vulnerable to iron or heavy metal contamination in mixed beds, since they are not protected by a cation unit, and the problem of organic matter fouling is also present *(47, 72)*.

Mixed Bed Equipment

Mixed bed demineralizing units are basically similar in materials of construction and hydraulic design to other ion exchange equipment although somewhat more complicated. Only one tank is required for a complete demineralizer, but the facilities for regeneration are more complex than for the single unit arrangements. A grid must be provided at the interface of the separated anion and cation exchangers to permit their regeneration. The backwash rate must be high enough to assure the complete separation of resins, or poor capacity and effluent quality will result.

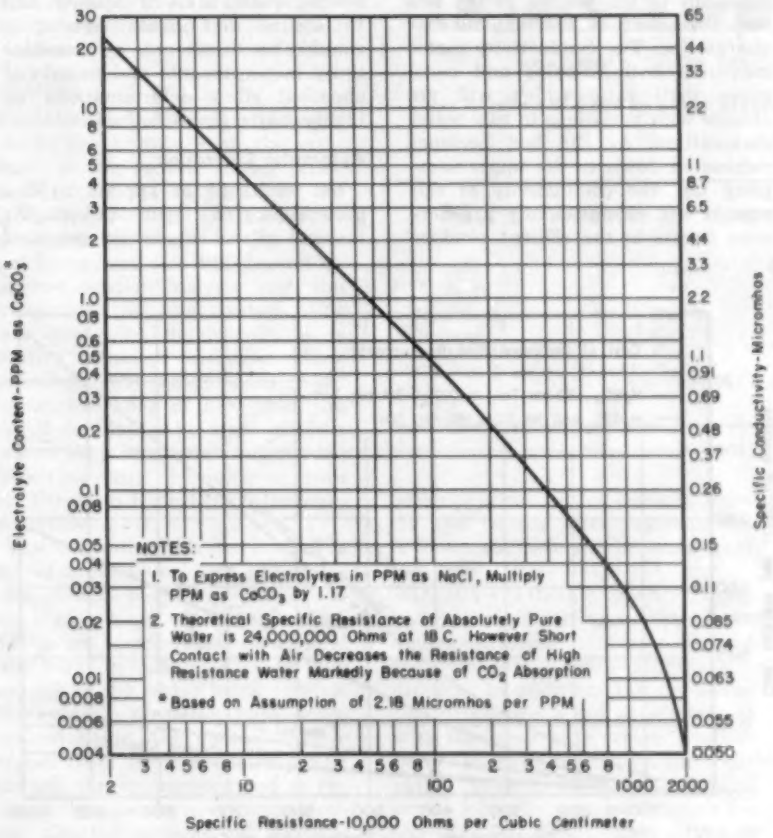
While numerous procedures have been considered for regenerating the resins following the separation by backwashing *(56)*, only two methods have been widely used. With one method, the first step is regenerating and rinsing the anion exchangers. Both the sodium hydroxide solution and the subsequent rinse water are introduced through the top inlet distributor, passed downflow through the anion resins, and withdrawn at the interface grid. Then the cation exchanger is re-

generated, the acid regenerant entering at the interface grid, passing downflow through the cation resins, and discharging at the bottom of the tank. Again, rinse water follows the same flow path and direction.

With the second method, both regenerants are introduced simultaneously, the alkali from the top down and the acid from the bottom up. Both regenerants as well as their subsequent rinses, which are also simultaneous, are withdrawn together at the center grid. In both methods, the interface grid must be carefully designed since its distribution characteristics are influenced by the fact that it is buried in the exchange bed. It must, of course, be covered with screening to prevent loss of exchange materials *(18)*.

Another important consideration in the design of mixed bed units is the supporting media. Materials such as gravel or anthracite coal cannot be used because they leach noticeable impurities into the very pure treated water during the run. Most systems utilize header-laterals formed to the shape of the bottom head of the tank, or flat bottom tanks with flat bottom collectors. Both of these arrangements must be covered with screens. Plastic granules, retained by screening, also have been used as support media.

Following regeneration and rinse, the bed must be mixed. This step is quite critical, since an incompletely or unevenly mixed bed will exhibit low capacity and will require an excessive long rinse to obtain the desired effluent quality. Since the resins have different settling rates, some water must be drained from the tanks after the mixing air is shut off to prevent stratification. On the other hand, a sufficient level of water is needed to assure that the bed is fluid enough to mix well. Piping must be provided at the bottom of the unit to introduce and properly distribute sufficient air to thoroughly mix the resins. After mixing, the unit is refilled with water from the top, and the next operating cycle can begin.



Purity guide. (Note: Curve applies only to waters containing neutral salts.)

General Considerations

Although demineralizing will produce water with only a few parts per million dissolved solids (down to a very small fraction of a part per million if mixed bed demineralizing is employed), it must be remembered that the process will not remove completely nonionized materials such as some organics. Incidence of these materials in water supplies is infrequent, however, and then only in very small concentrations which generally can be removed by coagulation or some other analogous process *(49)*. Additionally, the treated water is not necessarily sterile unless the raw water is sterile and the units are kept completely bacteria free. Typical demineralized water analyses can be found in the literature *(22, 26, 27, 44, 49, 61, 66)*.

One miscellaneous point that deserves attention is that ion exchangers tend to "hydrolyze" or bleed a slight amount of electrolyte during standing periods of no flow. This condition exists when ions that have been removed during the operating cycle leave the resins and go back into solution or when small amounts of electrolyte remaining in the ion exchange particles from the previous regeneration diffuse into the water. In either instance, a small amount of electrolyte may appear in the outlet water when flow is resumed. With multiple bed plants the concentration may amount to a few parts per million, but in mixed bed systems the effect is very slight—only a fraction of a part per million. Since the electrolyte soon disappears after operation is resumed, the initial flow can be discharged to waste if the water is objectionable *(18, 37, 56, 70)*.

The same condition can occur in multiple bed plants at very low flow rates (well below one gpm per cubic foot of exchanger per minute), but this can be avoided by recycling effluent water to the inlet to increase flow through the exchange units during periods of low water demand. With mixed bed plants, the effect is negligible and does not appear to cause too much difficulty.

Considerable experience is required to decide which exchanger is best suited to the water supply to be treated and what exchange capacity and treated water quality

will be obtained with given acid regenerant dosage. However, the volume of the exchanger can be estimated from the water analysis, the capacity of the exchanger, and the amount of water to be treated between regenerations. The first step in this procedure is to calculate the concentration of each ion, expressed in terms of calcium carbonate, using the formula:

$$\text{ppm as } CaCO_3 = \frac{\text{ppm} \times 50}{\text{Equivalent Wt. of ion}},$$

where 50 is the equivalent weight of calcium carbonate. Carbon dioxide and silica usually are considered to exchange monovalently in highly basic anion exchange.

Individual totals then are obtained for all of the cations and for all of the anions present in the raw water and are divided by 17.1 to convert to grains per gallon. From these data and the capacities of the respective exchangers in kilograins (thousands of grains) per cubic foot, the amount of water treated per cubic foot of resin bed can be calculated. The exchange unit then is proportioned to give the proper diameter for the required flow rate and the proper volume for the desired number of regenerations in a given time. At most installations it is desirable to regenerate each unit about once a day although more frequent regenerations can be used if necessary. The time required to regenerate a unit is one or two hours.

Various miscellaneous matters also must be considered in the design, such as providing additional capacity in the cation exchange units of multiple bed demineralizing plants for the water required to regenerate the anion exchange units. This is necessary since hardness elements (calcium or magnesium salts) are likely to precipitate in the alkaline environment of the anion exchanger and to cause leakage as they slowly dissolve, if raw water is utilized.

Instrumentation

The instrument most widely applied in demineralizing installations is the conductivity meter. This device measures the specific resistance or conductivity of the water by means of two electrodes. Since ionized impurities contribute to the conductivity, the rise in conductivity can be used to measure their concentration. Such information is valuable in maintaining plant effluent quality, and it also can be used for determining the endpoint of the run on demineralizers using weakly basic anion exchangers.

On installations using highly basic anion exchangers, effluent conductivity measurements will not detect the endpoint of the run because the first impurity to break through is silica, which is so weakly ionized that it does not change the conductivity. However, the strongly ionized electrolytes will have penetrated to a certain depth in the bed at the time the silica breaks through. If a sampling tap for the conductivity meter is placed in the bed at this point, a rise in the reading will accurately indicate exhaustion *(18)*.

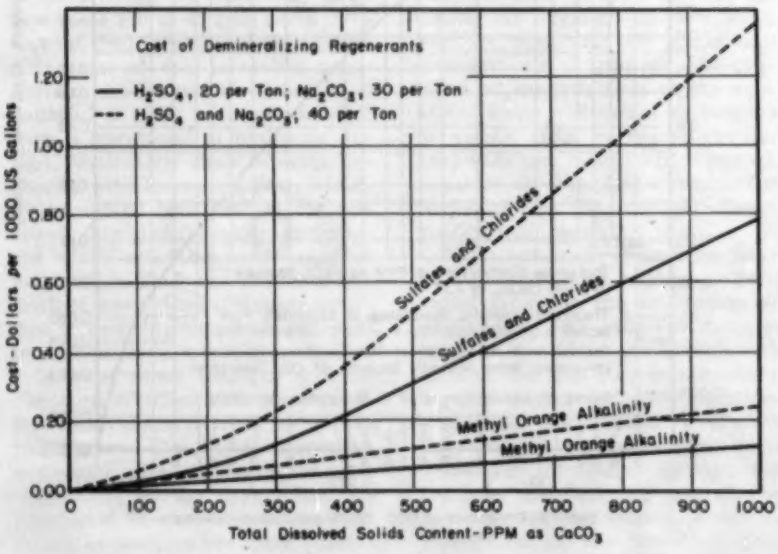
Although the conductivity of a cation exchanger effluent will change at the end of the run because the metallic ions have a lower conductivity than the hydrogen ion, the conductivity also will change with varying raw water composition. Thus, a single measurement cannot be used. Two sampling taps are required, one located above the bottom of the bed and the other in the effluent discharge line. The conductivity meter measures both samples and compares their ratio which will not change with variations in raw water composition. As the bed becomes exhausted down to the upper sampling tap, the conductivity of this stream will change before a difference occurs in the effluent conductivity. The resultant ratio change can be used as an endpoint indication for hydrogen cation exchange units *(21)*.

Some demineralizing plants employ pH meters to monitor effluents. These instruments also can be utilized to indicate exhaustion of cation units by the attendant rise in the effluent pH value, but they are subject to the same limitations as single conductivity measurements. With highly basic anion exchangers, raising the sampling tap in the same manner used for a conductivity meter will provide readings that show a pH change when the silica breaks through. However, this indication may be somewhat uncertain.

Actually, many demineralizing plants are operated on a volumetric basis, especially if the raw water composition is fairly constant. A water meter is arranged to signal when a volume equal to the calculated or predetermined capacity of the unit, less a safety factor, has passed through. This system, of course, wastes a bit of capacity, and to assure dependable results, it should be monitored by conductivity measurements and occasional chemical silica determinations on highly basic anion units.

Automatic Operation

Ion exchange as applied to demineralizing is a cyclic process. At the end of the run, which may oc-



Approximate costs of demineralizing water using weakly basic anion exchange.

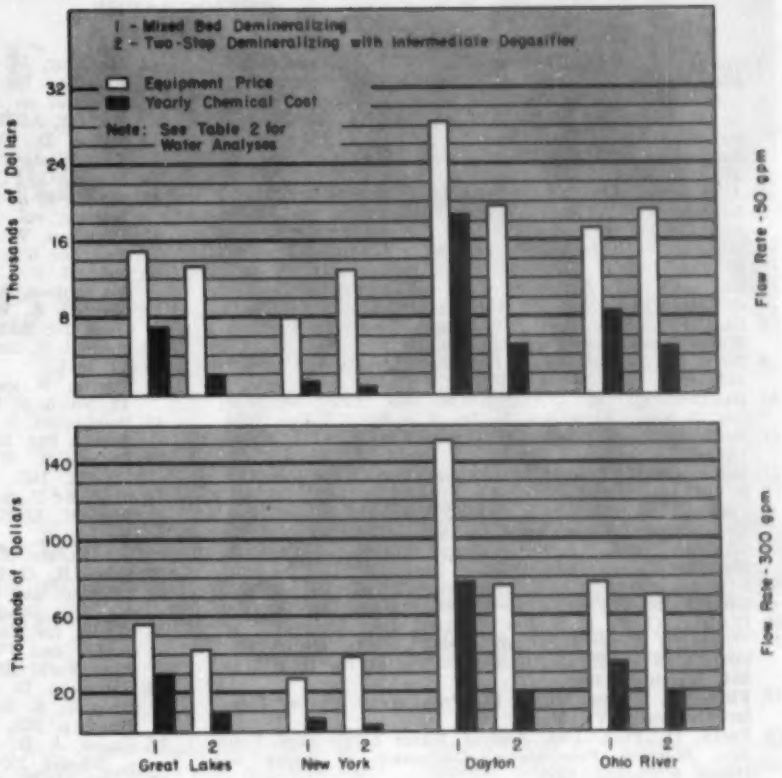
cur at an inconvenient time, the unit must be regenerated, and with manually operated equipment this procedure requires the services of an operator. Frequently, it is advantageous to arrange the system for automatic control, one common method being the use of a multiport or other type motor-driven valve. Timers or devices such as electrodes in regenerant tanks control the operation of the valve, with one of the monitoring instruments or a water meter serving to initiate the cycle *(18, 21, 48, 49)*.

On large units, the individual motor valves are pilot-controlled, while auxiliary flows are regulated by solenoid, hydraulic, or pneumatic valves that can be operated by solenoids from timers. Some systems also utilize such devices as butterfly valve backwash rate controllers, and level sensing electrodes in regenerant tanks to control the volume delivered. Even mixed bed units have been operated automatically. Another typical arrangement is the so-called "push-button automatic" system wherein the regeneration is automatic, but the cycle is initiated by the operator *(81)*.

Economics

Considerable information is available in the literature on the economics of the demineralizing process *(5, 13, 18, 22, 26, 30, 32, 34, 45, 46, 60, 61, 67, 72, 83, 84)*. The cost of regenerant chemicals is the principal factor, and this will depend on the raw water analysis and the arrangement of the system. For most conditions demineralizing is effective although estimates show that when raw water solids reach the neighborhood of 1000 ppm, the cost of distillation by some efficient method such as vapor compression (which may cost one dollar or more per thousand gallons) becomes competitive *(14)*.

Various authorities have cited a cost of around one cent per thousand gallons per grain per gallon for weak base demineralization. This is an approximate figure and will vary considerably with the analysis of the water being treated. For example, in weak base anion demineralizing, the carbon dioxide formed from the carbonates passes through the exchangers and is removed by inexpensive degasification. On the other hand, systems handling raw waters with high total dissolved solids contents may experience some loss of capacity during the rinsing after regeneration. A better estimate can be made from the graph *(60)*.



Costs of mixed bed and two-step processes using highly basic anion exchange.

TABLE 2 — ANALYSES OF FOUR REPRESENTATIVE WATER SUPPLIES

	ppm as	Great Lakes	New York (Catskill)	Dayton Ohio	Ohio River
Total hardness	$CaCO_3$	124	20	370	126
Sodium	$CaCO_3$	16	5	20	72
M.O. alkalinity	$CaCO_3$	98	12	278	45
Chloride & sulfate (ThMA)	$CaCO_3$	42	13	112	153
Silica	SiO_2	4	2.4	10	16

Demineralizing plants using highly basic anion exchangers have higher operating costs because they are regenerated with sodium hydroxide. In addition, the regeneration procedure is not as efficient as with the weak base resins. Evaluation will again depend on the individual project conditions. Typical costs for selected conditions are shown *(72)*. Exact cost estimates are best obtained by consulting a reputable manufacturer.

Demineralizing can be used wherever service requirements demand a completely purified water of distilled water quality. Current applications include: treating makeup for high pressure steam generating plants *(2, 46, 72, 83, 84)*, electroplating *(64)*, distilling *(41)*, textile processing *(69)*, ceramics manufacturing *(63)*, and numerous other services *(3, 43, 48, 49, 79)*. However, in judging the usefulness of demineralized water, the economics, the actual water quality requirements, and the limitations of the process must be evaluated for each particular installation.

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CARE OF INDUSTRIAL TUBES

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Electronic Tube Division
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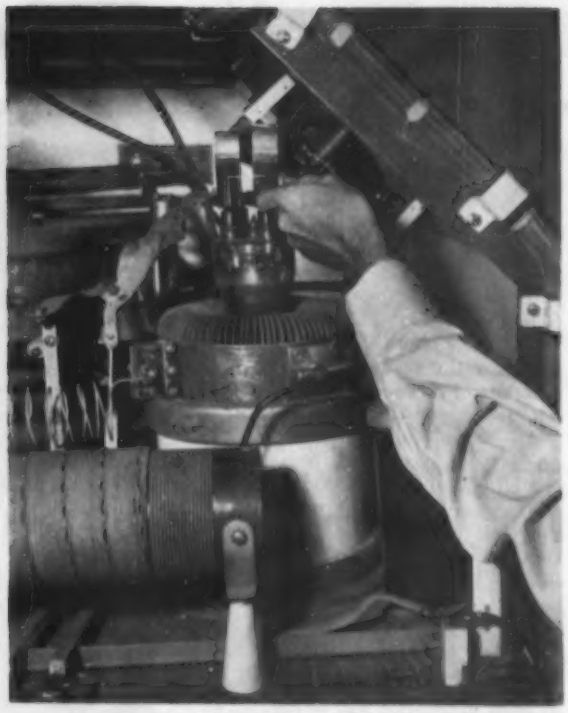


The finned, heat-dissipating connectors at top of tube are firmly re-attached after maintenance work is done.

OF ALL TYPES of industrial apparatus, the electronic device seems most complex and mysterious to the average maintenance crew. But electronic apparatus is electronic only because an electronic tube is involved in the circuit; remove this tube and the remaining apparatus is electrical and mechanical. The parts are familiar—interlocks, contactors, circuit breakers, motors, fans, water valves, switches, and rheostats. If conventional, common-sense maintenance techniques are applied to these familiar electrical and mechanical components, downtime can be reduced.

Electronic tubes are merely elements in the electrical circuit. Small tubes are mounted in sockets which make the electrical connections to the tube elements and furnish mechanical support for the tube. These sockets are a notorious source of trouble. Each time a tube is changed, the condition of the socket should be checked. Contact points should be clean, and springs not deformed or broken. Wires soldered to the socket should be examined for evidence of overheating.

For larger tubes, large-area connectors are used in place of sockets. The connectors should be clean, undamaged, as well as free of dirt, grease, and corrosion. The connectors must make firm, large-area contact with the tube to prevent the high tube currents from severely damaging the tube.

Two words of caution are in order: first, connectors should be firmly attached but not fastened so tightly that the tube is damaged. Second, a brownish-black deposit on silver-plated connectors does not detract seriously from their current-carrying capacity. This deposit should not be removed. If detachable heat-dissipating fins are part of the connectors, these should be firmly reattached after servicing.

Supply Voltages

Most electronic apparatus requires supply voltage as close to nameplate rating as possible. A voltage variation on the line of plus or minus 10 percent is usually acceptable, but any larger variation can cause trouble. Correction of a low or high supply voltage condition can materially improve reliability and add many hours of tube life.

In particular, the filament voltage of tubes is important. Almost all tubes require a certain cathode temperature for reliable operation. This temperature is maintained by the filament voltage which, therefore, must be correct.

In checking filament voltage, measure with an accurate voltmeter applied directly at the tube pin. The voltmeter should be calibrated frequently so that it maintains an accuracy of at least 2 percent at full-scale; ½-percent accuracy is preferable. The tube manufacturer's data sheet gives the proper voltage as well as the tolerance within which it must be held.

Tubes always generate heat when operating. Unless properly cooled, they will not function as intended. The apparatus designer provides for tube cooling, and his instructions must be followed precisely.

Cooling of small tubes is accomplished by making the glass bulb big enough to remove generated heat. Larger tubes require cooling by blowing air on the glass bulb or by dissipation through a radiator.

Other tubes are cooled by circulating water through a water jacket around the tube, much the same as an automobile engine is cooled. Water-cooled, high-power triodes have cooling water circulated around the outside surface of the anode. The anodes of these tubes operate very close to 100 C. If cooling water is hard, scale will deposit and reduce cooling efficiency. This water should be treated if the hardness exceeds 10 grains per gallon.

If the room in which the appa-

ratus is located is exceptionally hot, additional cooling beyond that provided by the apparatus designer may be necessary. In no case should the temperature ratings given by the tube manufacturer be ignored.

Low-Pressure Tubes

A widely used group of industrial tubes — known by the important sounding names Phanotron, Thyratron and Ignitron—have one characteristic in common: they are all filled with gas at low pressure. This makes them very efficient devices for the control of fairly large amounts of power but quite dependent upon operating temperature.

All these tubes also have the property of passing current in only one direction (from anode to cathode) when operating properly. If they fail to block the flow of current in the other direction (from cathode to anode) the tube is said to have "arced back," or that a "backfire" has occurred, or that the tube has "lost control." Almost any tube will arc-back once or twice during its useful life. However, if arc-backs become repetitive it is time to look for potentially serious trouble in the apparatus.

Poor cooling is the most usual cause of arc-back. If the tubes run too hot, their ability to block current flow from cathode to anode is seriously impaired. A tube filled with mercury vapor (all Ignitrons, and any Thyratron or Phanotron that has droplets of mercury inside) will not operate satisfactorily if the condensed mercury temperature is more than about 60 C.

Measuring Temperature

Condensed mercury temperature is measured on the outside of the bulb where a grey film indicates mercury is condensing. This area must be located near the bottom of the tube or arc-back troubles will be intensified. A tube filled with some other gas normally can be operated in any place where the surrounding (ambient) temperature is less than about 75 C. Blowers, air filters, water systems, as well as the tube temperature should be checked if a large number of arc-backs occur.

Mercury-filled tubes are also susceptible to over-cooling. If the mercury temperature drops too low, there will not be enough gas (ions) to carry current. Operation at temperatures below about 25 C can cause high-voltage surges that will damage costly circuit components. Tubes filled with other gases do not exhibit this characteristic at temperatures commonly encountered in industry.

Black wire wrapped under glass cloth tape leads to thermocouple being used to measure the temperature of the mercury condensing inside the tube.

The design of gas-filled tubes makes them very susceptible to low filament temperature. To insure proper tube life, the minimum rated filament voltage should occur at the lowest expected line voltage. Gas-filled tubes last longer if their cathodes are at or slightly above rated filament voltage.

Mechanical Structures

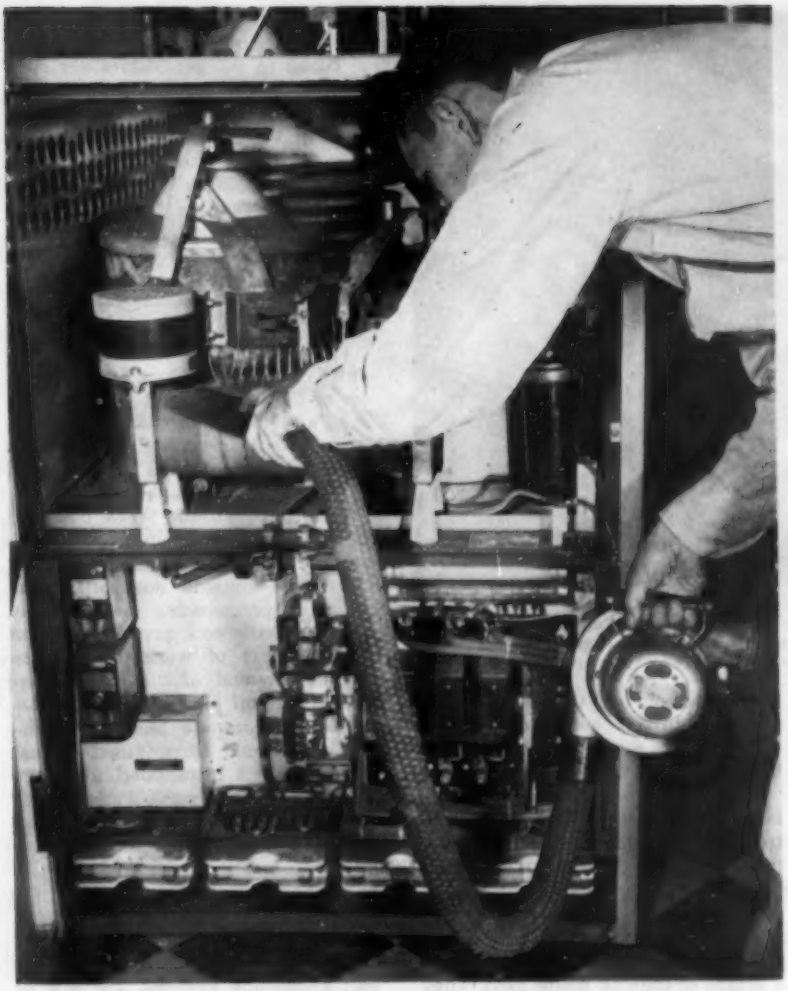
Tubes must also be recognized as mechanical structures of metal and glass. The tolerances on parts and spacing between parts is commonly a mil or less. This means that the tube is fragile. Bumps, jars, and excessive vibration should be avoided. Handle with care.

If several pieces of electronic apparatus of a given type are present in a factory, an accurate log of tube replacement becomes an invaluable general maintenance tool. Such a log will usually show up defective apparatus by pointing out excessively short tube service life.

Receiving Tubes

Tubes can be divided into eight categories; each has its own peculiar problems in addition to the foregoing general ones. Receiving tubes are small tubes of the type commonly used in radio and television receivers. Such tubes are used in the control and timing circuits of industrial electronic apparatus.

Receiving tubes must be replaced when their ability to amplify or control has dropped below a useful level. This constitutes the usual failure of receiving tubes. Other causes of failure—which are more or less accidental in nature — are loose internal parts, internal shorts



A vacuum cleaner is not only a valuable tool for periodic cleaning around tubes, but is good for keeping the entire interior clean and uncontaminated.

between parts, broken pins, and broken bulbs. Such failures are generally caused by vibration or jarring. All tubes should be checked for loose parts before going into service; vibration and jarring in service should be prevented.

Barring accidental damage, receiving tubes will give many hours of useful service. In general, industrial service demands are more severe and tube life is less than that encountered in home radio service. Unfortunately, there is no good way to check tubes for impending failure. If failure will lead to costly interruption of production, a regular schedule of tube replacement ahead of failure is probably the most economic solution. In other cases, watch for signs of erratic operation, of loss of accuracy, or drop in precision in the apparatus. Replace tubes when such symptoms appear. The use of a tube log will help materially in establishing a good replacement schedule.

In general, commercial tube testers are not adequate for testing tubes used in industrial applications. They may reject tubes that are good or they may accept tubes that will not work at all. The only absolute check is operation in the circuit. Some tube users may find it desirable to build—or buy from their apparatus supplier—a circuit that will test tubes under the same conditions as those imposed by their particular apparatus.

Gas-Filled Tubes

Phanotrons (gas rectifiers) are usually found in medium- to high-power rectifiers. They usually fail for one of two reasons: either the filament breaks or the tube begins to arc-back excessively. Unless such failures are caused by mechanical injury to the tube or by improper care of the tube, they may both be the results of normal "using up" of tubes. Low filament voltage is a common cause of short operating life of Phanotrons.

In the event of filament burn-out, the d-c voltage supplied by the rectifier will drop, and the rectifier will no longer supply power properly. The burned-out tube can be spotted immediately by the lack of a normal bluish glow between plate and filament.

Impending Burn-Out

If the number of arc-backs becomes excessive, one or more tubes is probably nearing the time of filament burn-out. Since an arc-back puts a direct short through two tubes across the secondary of the rectifier transformer, arc-back can be detected by the fact that the a-c breaker opens or that the a-c line fuse blows. The tube giving trouble often exhibits visible characteristics different from its neighbors.

Phanotrons are commonly used in rectifiers having an output voltage from 1000 to 20,000 volts, d-c. Such voltages are exceedingly dangerous. Great care should be taken to assure removal of all voltages before changing tubes. Remember that filter capacitors may be present and holding a charge that is equal to the ouput voltage even after power has been turned off; solid electrical connection between positive and negative output terminals should be made before working on the circuit. At these high voltages the insulation between parts and ground and from part to part must be kept especially clean and in good condition. Oil grease, moisture, and dirt — especially dirt—can cause costly failure.

Thyratrons

Thyratrons are much like Phanotrons except for the addition of one or more control elements (grids) inside the tube. They are used in large resistance welders as ignitor firing tubes or as the output tubes in small resistance welders. They are also used in equipment such as speed regulators, control circuits, timers, and counters.

The same comments apply to the maintenance of Thyratrons that apply to Phanotrons. End of life occurs by filament burn-out and by loss of control or arc-back. Erratic or inaccurate operation of control apparatus may be due to failure or near-failure of Thyratrons.

Besides having more elements present inside the tube, the Thyra-

Tube Type WL 5936 Located in Socket No. 2A
Type of Apparatus R F Generator Unit No. 2
In Out Reason
7/2/50 8/12/51 To #3A Socket
8/12/51 10/2/51 Breaker Failed To Clear Arc
10/2/52 5/1/53 Open Fil
5/1/53 3/2/54 Open Fil
3/2/54

A simple file card system containing up-to-date, essential information constitutes a valuable log of data that pin-points potential trouble.

tron is also required to do more than the Phanotron. Therefore, life of Thyratons is commonly shorter than life of Phanotrons. In addition to low filament voltage, improper or defective grid circuit resistors reduce tube life.

Ignitrons are the last of the group of gas-filled industrial tubes. They differ from the other two by having no filament. A mercury pool serves as the cathode and conduction is initiated by passing current through the tube's ignitor. These tubes have the longest service life of all industrial tubes. Life in welding service will be adversely affected by improper cooling, by overloading, or by poor electrical connections to cathode and anode.

Ignitor Failures

Ignitrons ultimately fail by developing faults in the ignitor circuit or by developing excessive arc-backs. Ignitor circuit failure is usually due to gradual using up of the ignitor element until it no longer touches the mercury pool.

Sometimes the mercury becomes contaminated by material from the tube walls or from the anode, and then the ignitor is wet with mercury. The ignitor is thus shorted and will no longer fire the tube. An ohmmeter reading higher than 100 ohms (800 ohms for rectifiers) or less than 10 ohms between ignitor and cathode (mercury pool) will indicate a tube that may be defective.

Excessive arc-backs are usually caused by a slow air leak, or by contamination of the anode with mercury. In any event, an ignitron (operating at a proper temperature) that arc-backs frequently has failed.

Another class of industrial tubes includes the high-vacuum Kenotrons and Pliotrons. Kenotrons are two-element (diode) tubes. Pliotrons are three-element (triode), four-element (tetrode), or five-element (pentode) tubes. These tubes all have filaments that operate at a bright orange or white heat. They are cooled by air, water, or oil—depending upon their particular application. Tube life is critically dependent upon proper filament voltage and somewhat dependent upon proper cooling. Unlike the gas tubes, operation at temperatures as high as 150 C is possible.

Kenotron Burn-Outs

The use of Kenotron tubes in industry is somewhat limited. They are found in power supplies for electrostatic precipitators and X-ray power supplies. They usually fail by exhaustion of the filament (burn-out). Life depends upon the type of service and the type of cathode in the tube. For pure tungsten filaments, a five-percent increase in filament voltage cuts the tube service life in half.

High voltages are always involved with Kenotrons. Since they are small in size, an insulation failure will usually destroy the tube. Proper maintenance demands a high degree of cleanliness. Extreme caution is the rule in maintaining this equipment since dangerous voltages are involved.

Tubes in r-f generators are subjected to extremely severe operating conditions. In all such generators, the anode-to-cathode voltage is high—from 2000 to 20,000 volts, d-c, and from 2000 to 40,000 volts, r-f. Thus, the chances for an internal tube arc are high. Such arcs must be interrupted very rapidly to prevent tube destruction.

Arcs Crack Glass

Arcs outside the tube crack the glass or puncture glass-to-metal seals. This means that overload relays and circuit breakers must be in excellent operating condition at all times. Arcs should be prevented at all costs. Cleanliness is vital.

Arcs between the work coil and the work will often induce arcs internally in the tube or externally along the outside surface of the tube. Proper spacing between the work and the coil, proper insertion and removal of work, as well as proper removal of dirt, accumulations of metal chips, and other debris can eliminate such arcs. Interlocks should be provided so that power cannot be applied until the work is in place. Proper maintenance of such auxiliary control parts of the apparatus is all important.

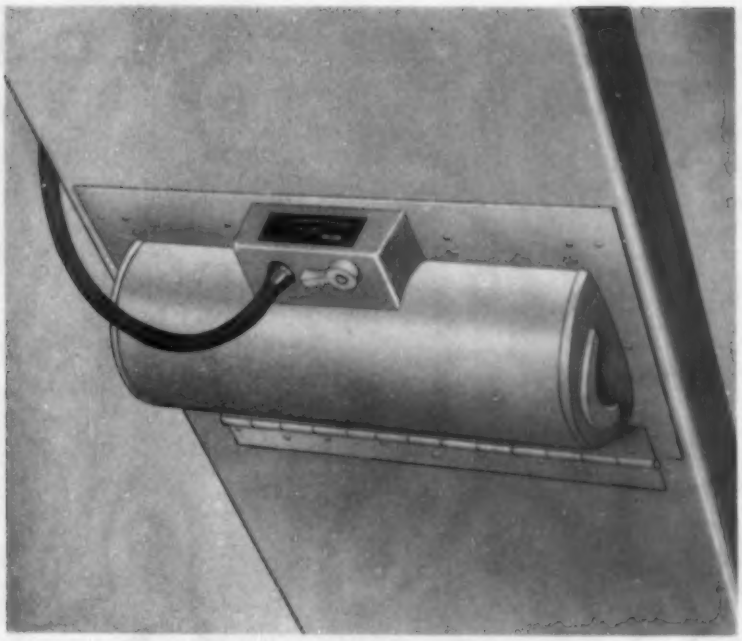
Phototubes

Phototubes are no problem in themselves—they require essentially no maintenance and have long life. But phototube systems are one of the most difficult to maintain; this difficulty is due primarily to certain phototube characteristics.

Resistances used in phototube circuits are measured in megohms (millions of ohms), and must be held to fairly precise tolerances. A small amount of moisture and dust can make a photoelectric device inoperative. The voltages are low, but problems of insulation and cleanliness are of prime importance.

Photoelectric apparatus is especially vulnerable to line voltage variations. Photoelectric control should be excited from a well regulated supply (such as the plant lighting bus) in order to provide reliable performance.

Electronic apparatus is being more widely used throughout all phases of industry. Whether the device is for automatic control, counting, heating, or measuring—it is there because it does the job better or at less cost than other available methods. A good maintenance program will enable the equipment to do the job for which it is designed.



Magnetic collector on the coal chute separates tramp iron from the coal.

Simple Magnet Alarm

Protects Our Coal Pulverizers

RALPH BEALS
Plant Maintenance Department
Carborundum Company

EXPERIENCE HAS SHOWN that tramp iron will occasionally appear in a coal shipment delivered to an industrial plant. Since tramp iron can cause costly damage to the pulverizing machinery, it is generally advisable to use some method of screening or separating these foreign metal objects from the coal.

Some months ago, the Carborundum Co. in Niagara Falls, N. Y., installed a non-electric permanent magnetic separator with an automatic alarm light on their incoming coal chute. The unit is at the discharge end of the hopper that feeds rice coal directly from the railroad cars to a coal pulverizer. As thin layers of rice coal pass down the 20 in. wide chute, any iron in the coal stream is separated and held by the plate magnet. A light flashes on the main floor after a predetermined amount of iron has been collected. This immediately notifies the operator to shut down the coal unloading system and clean the tramp iron from the collector.

Once the warning light is actuated, it cannot be shut off until the iron has been removed from the magnetic element. A switch is used to reset the unit.

Although the location underneath the coal chute is particularly awkward and difficult to reach, by releasing a catch and swinging the collector plate outward on its hinges, it becomes readily accessible to the operator or maintenance man.

The unit can be pre-set to give a warning indication for any (within limits) desired accumulation of iron. The so-called "brain element" is a precision magnetic instrument (Ferrometer) which measures the permanence change in the magnetic circuit brought about by the tramp iron accumulation across the magnet's air gap. This element measures a magnetic condition, signaling when the effectiveness of the magnet reaches a limiting point. The amount of iron accumulation necessary to actuate the element can be adjusted according to maximum and minimum accumulations that experience has shown should be permitted to collect on the magnet.

Called "Magnalarm" by its manufacturer, the Eriez Manufacturing Co., Erie, Pa., the unit requires no electrical energy except that required by the connected signaling devices. The Magnalarm system can also be made to operate any other types of signals—besides a light—including an automatic shutdown.

The unit is sealed and has no mechanical moving parts. In spite of the wear, grime, and corrosive conditions encountered in its location and services, the Magnalarm has required no maintenance.

In operation, the Magnalarm has effectively removed tramp iron before it could reach the pulverizer. The operator cleans off the accumulated iron two to three times a week, depending on the actual coal delivered. It has proven an effective maintenance tool in protecting expensive pulverizing machinery equipment in this plant.

A close-up of an upright spray sprinkler head installed directly under a sheathed ceiling.

Automatic Spray Sprinkler Heads

A More Effective Means of Fire Protection

I&P EXCLUSIVE

N. D. SHERWOOD
Rockwood Sprinkler Co.
Worcester, Mass.

THE CAREFULLY KEPT records of the National Fire Protection Association prove that nearly 97 percent of all fires in sprinklered buildings have been held in check or completely extinguished by the sprinkler equipment. However, the changing conditions in industry and the introduction of hazards that were not contemplated when the sprinklers were originally installed in manufacturing and industrial buildings have endangered the efficiency record of the standard automatic sprinkler system.

Every process that tends to speed up production may also introduce new fire hazards which standard automatic sprinkler systems cannot always be expected to extinguish or control. One example is the growing use of industrial lift trucks and the increased practice of high piling raw materials and finished products. In new plants where high piling can be expected, allowances can be made in designing the automatic sprinkler system. By closer spacing of sprinkler heads and increasing pipe sizes and pressures, efficient protection with automatic sprinklers is still possible. However, in buildings already erected and occupied, the economics of removing existing automatic sprinkler systems and installing more suitable equipment can

hardly be justified in most cases.

The accepted standards for the approval of automatic sprinklers as established by the testing laboratories of both stock and mutual fire insurance companies have required that approximately 60 percent of the water discharged from the sprinkler should be directed against the ceiling; approximately 40 percent of the water should be discharged in a generally downward direction; and 90 percent of this water should fall in an area ten feet square when the sprinkler head is installed ten feet above the floor and with a pressure head of five pounds at the discharge. The water discharged against the ceiling falls to the floor in such large drops that the greater part of their ability to absorb heat is lost. Also, the water discharged against the ceiling covers only a small part of the ceiling itself. Even under smooth ceilings and with comparatively high pressures, the actual area wetted by the automatic sprinkler will not constitute more than 25 percent of the total ceiling area covered by each sprinkler.

Fine Spray

On the other hand, by breaking water up into a finely divided spray, more surface area is exposed which greatly increases the heat absorbing qualities of the water. At the same time, the smaller particles of water are more quickly changed to steam by the heat, thus creating a smothering blanket.

During World War II, the U. S. Navy proved the effectiveness of water spray protection to extinguish flammable liquid fires aboard ships. The entire technique of municipal fire fighting underwent a radical change when municipal fire departments began extensive use of water spray nozzles. However, until 1949, the general application of water spray was confined to municipal fire fighting and to the protection of special hazards such as electrical transformers, quench tanks, dip tanks, and asphalt saturators.

Conclusively Proven

Nevertheless, it had been conclusively demonstrated that water spray or waterfog possesses a remarkable cooling and smothering effect, and, that fine water spray, discharged from water spray nozzles or heads, is especially effective in controlling fires involving flammable liquids. Taking this into consideration, the *Standards for Water Spray Systems for Fire Protection, Pamphlet 15,* promulgated in 1947 by the National Board of Fire Underwriters state: "Water Spray is applicable for protection of specific hazards and equipment and may be installed independently of or supplementary to other forms of fire protection systems or equipment. Water spray systems are not ordinarily intended to replace automatic sprinklers."

Until 1949, all water spray heads were of the open type. In case of fire, when the system was operated either automatically or manually, water was discharged through all of the heads on the system. Obviously, with all heads discharging simultaneously, the use and application of such systems was confined to special hazard protection.

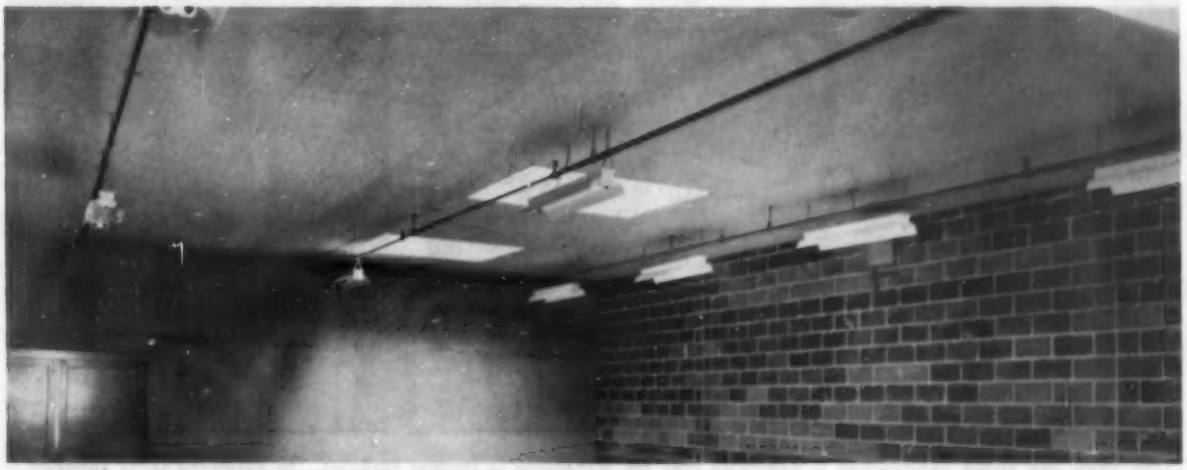
That same year, the Rockwood Sprinkler Co. produced a series of spray heads which could be used as either open heads or sealed against water pressure by the same sprinkler linkage used in conventional sprinklers. These heads were designed with different discharge characteristics and were approved as either open or sealed water spray sprinklers by both of the Underwriters testing laboratories and listed as "Special Type Sprinklers". The heads were built to be installed in a pendent position and differed from conventional heads in that all of the water discharged from the heads was directed in a downward direction, with no water being discharged in an upward direction.

The Associated Factory Mutual Laboratories and the Underwriters Laboratories, Inc., representing the fire insurance industry, have now set up standards of performance for spray sprinklers. At the present time, spray sprinklers manufactured by sixteen sprinkler manufacturers have been approved for installation in the upright or pendent position.

Controversy

Quite naturally, the development of the spray sprinkler has aroused considerable controversy. It has been rather difficult for fire protection engineers who have not had the opportunity of witnessing actual fire tests to quickly accept a complete reversal of earlier theories regarding automatic sprinkler protection. Questions such as: "How can you expect ceiling protection from sprinklers that do not throw water on the ceiling?" "What happens when a fire originates in the ceiling above the sprinkler heads?" "Isn't the decreased efficiency of the spray sprinkler being used up in the proposed increased spacing?"

The testing laboratories knew



Note the wide spacing of spray sprinkler heads, as recently allowed by new spacing rules, in this planned office area.

COMPARATIVE FIRE TESTS BETWEEN REGULAR AND SPRAY SPRINKLERS

Test Number One	*Test Number Two*
Heads Tested — Standard 165 F automatic sprinklers.	Heads Tested — 165 F spray sprinklers
Spacing — 10 ft x 10 ft, or 100 sq ft per head.	Spacing — 13 ft 4 in. x 10 ft, or 134 sq ft per head.
Heads Opened by Fire — 6.	Heads Opened by Fire — 2.
Total Water Discharge — 90 gpm.	Total Water Discharge — 30 gpm.
Maximum Temperature Over Fire — 1470 F.	Maximum Temperature Over Fire — 1430 F.
Average Five Minute Temperature During Test — 1370 F.	Average Five Minute Temperature During Test — 130 F.
Temperature Above 1000 F — Ten minutes.	Temperature Above 1000 F — One minute.
Test Results — Fire not extinguished by sprinklers. Center of cribbing burned out. Extinguishment completed with hose lines after 20 minutes.	Test Results — Fire extinguished in 6 minutes and 25 seconds.
Material Burned — 188 pounds.	Material Burned— 18 pounds.

many of the answers. Every type of fire, under all types of ceiling constructions, with the fire being originated in every conceivable location, was reproduced, and the spray sprinkler was compared with the regular automatic sprinkler. In all of these tests the spray sprinkler continued to prove its superiority.

In 1953, the National Fire Protection Association requested the Committee on Sprinkler Rules of the Association to study the present rules and to present to the Association rules covering the installation of spray sprinklers to be considered by the National Fire Protection Association during the 1953 meeting of the Association at Chicago for final consideration and action.

Prior to their consideration of this new development, a committee of the outstanding fire protection experts of this country and Canada was selected to witness comparative tests between regular sprinklers and spray sprinklers, with the spray sprinklers installed on a spacing 34 percent wider than the spacing for regular heads on the same system.

The tests were conducted over cribbing, mostly of timbers 2 x 4½ in., built up to a point where the top of the cribbing was 36 in. below the sprinkler deflectors. The cribbing material weighed approximately 450 pounds. The sprinkler discharge in both tests was 15 gpm per head. Ignition was made by means of cellu-cotton igniters saturated in gasoline in the cribbing.

The first sprinkler head opened in

The beam and girder construction is commonly used for warehouse or storage facilities. The automatic spray sprinkler has proven particularly effective in minimizing potential storage hazards as well as hazards inherent in this type building.

Under open joists, spray heads are nipped up to bring deflector tops proper distance below bottom of joists.

High piling in a lumber storage warehouse represents a special hazard for the sprinkler protection system.

one minute and twenty-five seconds after the start of the test. After each test the remaining material was thoroughly dried and then weighed to determine the exact amount of material destroyed in the test fire. Thermocouples were installed so that temperatures could be noted throughout the entire test. All recorded temperature readings were taken after the operation of the first sprinkler head in each test.

The two recorded tests showed the marked superiority of the new spray sprinkler. They also proved conclusively that increasing the spacing of the spray sprinklers definitely did not use up their acknowledged increased efficiency. The fact was emphasized that increased efficiency in sprinkler protection may be expected in the future.

Spacing Standards

Following these tests, the sprinkler rules committee suggested standards for the spacing of spray sprinklers. Their report was submitted to the National Fire Protection Association at the Chicago meeting. The suggested rules were unanimously adopted by the convention and thus automatically became a part of the *Standards of the National Board of Fire Underwriters, Pamphlet No. 13.*

What does the new spray sprinkler mean to industry? The question can be considered in two parts: first, how will the new spray sprinkler benefit those industries and those buildings where sprinklers have already been installed; and second, what are the advantages of having spray sprinklers in new installations of fire systems.

Existing Systems

In buildings already equipped with automatic sprinklers, spray sprinklers may be substituted for regular sprinklers without any change in the existing sprinkler piping, sprinkler valves, or any part of the basic equipment, and increased efficiency in present sprinkler protection can be expected.

Two types of spray sprinklers have been approved by both underwriting laboratories, upright and pendent heads. Present installations with either conventional upright or pendent heads can substitute upright or pendent spray sprinkler heads without difficulty. However, pendent heads cannot be installed on dry pipe systems.

New Installations

In new installations with ordinary occupancies, wider spacing of spray heads will be allowed. This will mean fewer sprinklers are required to protect a given area. In large installations involving a number of systems, fewer controls will be needed. This can reduce the water requirement and bring about lower operating costs.

The spray sprinkler can be expected to greatly improve automatic sprinkler protection by:

¶Better ceiling protection with less damage to the building itself;

¶Quicker and more efficient cooling that increases effective extinguishment;

¶Less damage to materials involved in the fire;

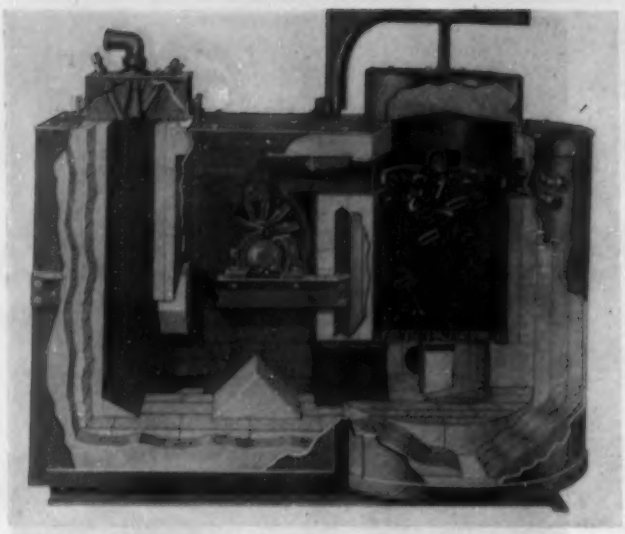
¶Less water damage from excess sprinkler discharge.

Precautions

There are two precautions that should be emphasized in installing and maintaining spray sprinkler systems. Probably the most important is the necessity for differentiating between upright and pendent heads. The upright head will not be effective in a pendent position nor will the pendent head be effective if installed upright.

One other warning. Spray sprinklers may be substituted for conventional sprinklers in an existing system and greater efficiency may be expected. Regular sprinklers, however, cannot be substituted for spray sprinklers installed under the present standards without seriously affecting the efficiency of the sprinkler protection.

The automatic sprinkler has shown an excellent record of fire protection over the past years. There is reason to believe that the new automatic spray sprinkler will provide even greater efficiency and a still better performance record.



Cutaway drawing of gas furnace shows burner port under charging area, and labyrinth through which hot gases flow.

Coiled resistors just left of center (above) are located over circulating fan in electric furnace.

Gas Furnaces--Electric Furnaces

Which Suits Your Job?

JOHN R. DUFFY
Assistant Chief Engineer
Lindberg Engineering Company

I&P EXCLUSIVE

SINCE THE PRIME purpose of any industrial furnace is to bring its charge to a pre-determined, uniform temperature as quickly and as evenly as possible, the source of its heat represents only a means to the end. Electric and gas-fired furnaces are diversified tools of modern industry and are not the fierce competitors that some engineers would lead us to believe.

Basic Differences

The basic difference between the electric and gas-fired furnace is the manner in which sources of energy are converted to heat. In the electric-powered unit, a voltage applied at the terminals of a resistor produces heat whose wattage is represented by the relationship I^2R. These resistors are placed within the furnace in such a way as to liberate their heat in the most efficient and uniform way.

The gas-fired furnace, on the other hand, derives its heat from the energy released by the combustion of a gas flame. Though the temperature of this flame is in the neighborhood of 3550 F, the construction of the furnace must permit utilizing the heat in work chambers having considerably lower temperatures.

Both the gas and electric furnace make varied use of the three modes of heat transfer—conduction, convection, and radiation. But though conduction is always present in any furnace, it is generally of secondary importance; it accounts for only the heat that flows from the hearth to the work where physical contact exists, and for heat internally distributed within the charge and the surrounding refractory. Convection and radiation are of more concern.

The most successful electric convection furnaces have a separate chamber in which a high-volume, high-pressure fan forces the heating medium (usually air) across the hot coiled electrical resistors and thence through the furnace chamber, where the heat is transferred to the charge. In the gas-fired adaptation of this design, hot products of combustion liberated by the gas flame are drawn into a recirculating fan chamber; here they are mixed with, and tempered by, the furnace's recirculating gases before passing to the work chamber. Both furnaces are similar in construction inasmuch as they have identical work chambers; the dissimilarity is confined to the adjacent convection space.

As a rule, the electric resistors are mounted on a self-contained frame and are set in the furnace immediately above the circulating fan. All electrical connections are on the exterior of the furnace and coil replacement is only a matter of removing one resistor assembly and inserting another.

Separate Chamber

Gas firing requires a separate combustion chamber to shield the fan from the intense heat of the gas flame; heat transmission occurs only through the mixing of the hot combustion products and the recirculating furnace chamber gases. The burner itself is generally attached to the combustion chamber in much the same way as the electrical element assembly is inserted in its furnace; burner replacement is performed in precisely the same fashion after the connected piping has been removed.

Convection-type heating, either

gas or electric, has been employed almost exclusively in the temperature range up to 1400 F until recently. Where many different heat-treating and other processing operations are performed in this temperature range, it is the most effective way known to obtain rapid and uniform heating. Recent innovations in furnace design, however, permit full-convection furnaces to operate satisfactorily up to 1750 F.

High Temperature Range

In the 1400-F to 2100-F range, the difference between the gas and electric non-convective furnaces becomes more pronounced. In the absence of a circulating fan, the electric furnace depends wholly upon radiation to transmit its heat from source to work; the gas-fired furnaces use both the radiant effect of furnace refractories and the convective effect of its hot gases to heat the charge. Typical of the gas-fired unit in this temperature range is the underfired type; gas burners fire through ports or sealed refractories in the furnace wall and into the space beneath the furnace hearth. Here the intense flame is shielded from the charge by the hearth refractory, and the hot combustion products are forced to pass up along the side walls of the furnace, through the furnace charge, and then to the flue.

The furnace refractory, heated by the moving gases and the highly radiating hearth, then re-radiates to the furnace charge. This radiation, in conjunction with the heat picked up from the scrubbing action of the hot combustion products on the charge, produces by far the greatest portion of the heat accepted by the work in the furnace.

On the other hand, the electric furnace is designed with metallic resistors placed strategically about the furnace chamber to present a uniform heating pattern. Floors, walls, and (in some cases) the roof are "hung" with heating elements. Through the selection of proper electrical wattage for any given radiating face, the entire chamber is void of the usual hot and cold areas associated with radiant heating. Convection within this type of furnace is due solely to the natural currents arising from the temperature differential between the top and bottom of the furnace; for the sake of this discussion such convection can be safely ignored.

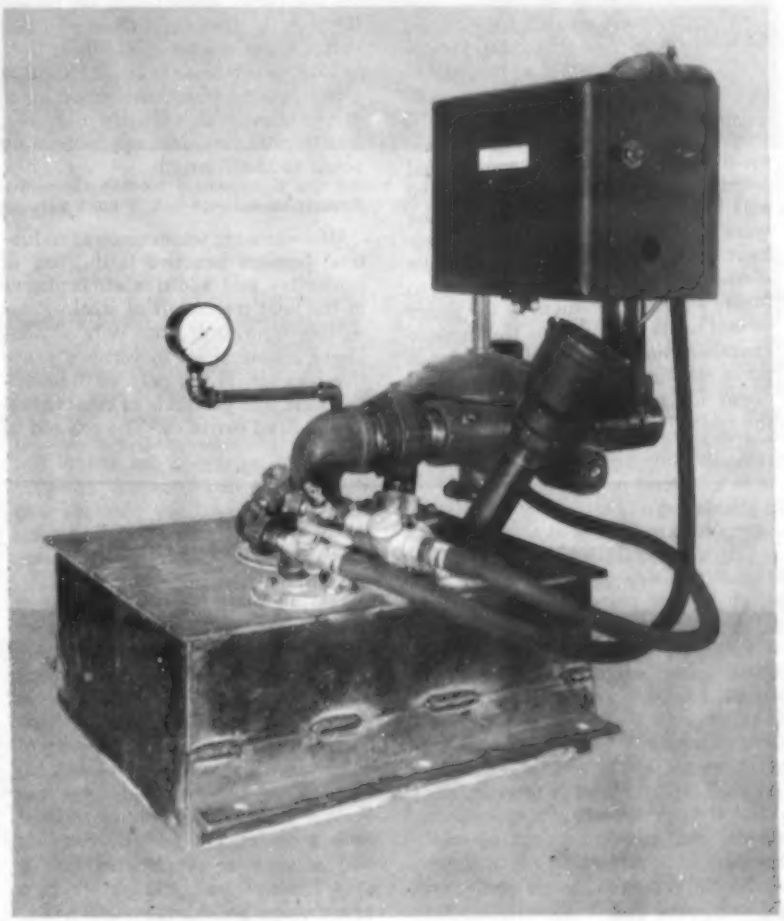
Appearances

A difference in appearance between the gas and the electric furnace for the 1400-F to 2100-F range becomes quite evident. Because it must confine temperatures exceeding 3000 F and withstand the effect of heated gases attempting to force their way from the furnace envelope, the gas-fired unit must be rugged. Its design is characterized by the use of much heavy refractory, capable of withstanding the thermal shock of intermittent firing and the erosion of the hot gases produced by the flame. As a rule, the encasing steelwork of a gas furnace is heavier and more amply reinforced than in its electric counterpart because of the deleterious effect of hot pressurized gases at such points as doors, burners, and thermocouple tubes.

In contrast, the electric furnace is quite streamlined in appearance; the symmetry of its outer shell is interrupted only by the heating element terminals. These elements are fabricated from 80-percent-nickel, 20-percent-chromium alloy, selected primarily because of its constant resistivity over the temperature range involved and for its ability to withstand the corrosive action of the furnace atmosphere. Preformed from bar stock into "overbends" (or elongated loops), the elements are secured to the furnace refractory by means of heat-resistant alloy pins.

With the exception of the furnace hearth (which can be either cast heat-resistant alloy or high-conductivity refractory) and the support piers, the entire heating chamber is generally constructed of lightweight insulating refractory. Not being burdened with a large amount of dense, heat-absorbing refractory, the electric furnace has a much faster heating-up time than a comparable gas design, and it responds much more quickly to the control action of the pyrometer.

It should be mentioned that the presence of dense refractory in gas furnace construction is a very great asset in certain cases. Because of its heat-absorbing characteristics, it can act as a thermal flywheel and



Typical burner assembly for gas-fired convection furnace includes burner block, mixing equipment, pilot, safety device, and proportioning control.

retard the reduction of chamber temperature upon the insertion of a cold load. Furthermore, in those operations which require considerable soak time, this refractory is able to replenish its heat content without increasing the cycle time.

As the operating temperature of industrial furnaces approaches 2500 F, another modification in conventional design takes place. In both the gas and electric units, it becomes necessary to increase insulation thickness to prevent the greater portion of the input from being dissipated as radiation loss from the furnace envelope. The input to the gas furnace must be increased to compensate for the inherently high flue losses at such temperatures.

Ceramic Resistors

Further, in the electric furnace it becomes necessary to replace the metallic resistors with ceramic types, capable of withstanding 2500-F temperatures. These ceramic resistors are preformed in the shape of solid round bars having end terminals of similar section but low electrical resistivity. Since these resistors must be used in their commercially available form, they are not as flexible as the metallic type and are confined to those locations where they can be supported without excessive stress on the element itself. Conventional practice finds them located above and below or at either side of the work charge; they transmit their heat in the same fashion as metallic elements. Since it is impractical to locate a ceramic element in the doors or end walls of a furnace, the furnace chamber must be lengthened for a given uniform heating length to account for increased heat release at the ends.

The gas-fired furnace will occupy slightly larger floor space than its electric counterpart. In the recirculating type of furnace, this is represented by the extra chamber required for the combustion of the gas. The added floor space in the high-temperature furnaces is taken up by the projection of the furnace piping plus that area required for adequate combustion of the fuel.

The amount of floor space that must be allotted for the servicing of each type of furnace is also important. In all cases, the gas burner must be removed from the outside of its furnace; ample space must be provided for dismantling the piping as well as for the removal and reinsertion of the burner tile.

The compact, coiled resistors of the electric recirculating furnace are removed as a unit externally, along with the frame and mounting plug. The metallic resistors of the higher temperature electric furnace are usually removed from inside the furnace chamber after they have been disconnected. The ceramic resistors, on the other hand, must be passed through the furnace wall or roof and thus require a space which is at least as long as the resistor itself. Radiant tubes, having much the same space requirements as ceramic resistors, also require clearance approximately equal to their length.

Atmospheres

Of increasing importance in industrial furnace practice is the use of protective and additive atmospheres in the heat treatment of steel. Prior to this innovation, the only atmosphere encountered in furnace practice was air, in the case of the electric unit, and products of combustion in gas-fired furnaces. The oxygen in the air plus the carbon dioxide and water vapor of the combustion products were conducive to production of scale and were active in decarburizing the surface of the steel. To alleviate this condition, neutral atmospheres permeating the furnace enclosure, to the exclusion of all other gases, are employed.

Hydrocarbons

Other developments are the addition of such components as hydrocarbons and ammonia to increase the surface hardness of the steel, i.e., gas carburizing and carbonitriding. The problem of encasing these gases and keeping them free from contamination has become one of the major problems today. It has been the direct cause of the radiant tube design, permitting gas-fired furnaces to compete with electrical brethren in places never before thought possible. Prior to this, protective atmosphere furnaces with gas firing were held in disfavor because of the expensive and generally inefficient muffle needed to prevent contamination of the protective gas by the products of combustion.

Although the electric furnace has been considered far better suited to the use of atmospheres than the original gas units, it, too, has had to undergo considerable refinement to make it commercially acceptable. Air-tight seals around element terminals had to be developed, and elements themselves were redesigned as well as repositioned to eliminate the possibility of short-circuiting across carbon bridges precipitated from the atmosphere.

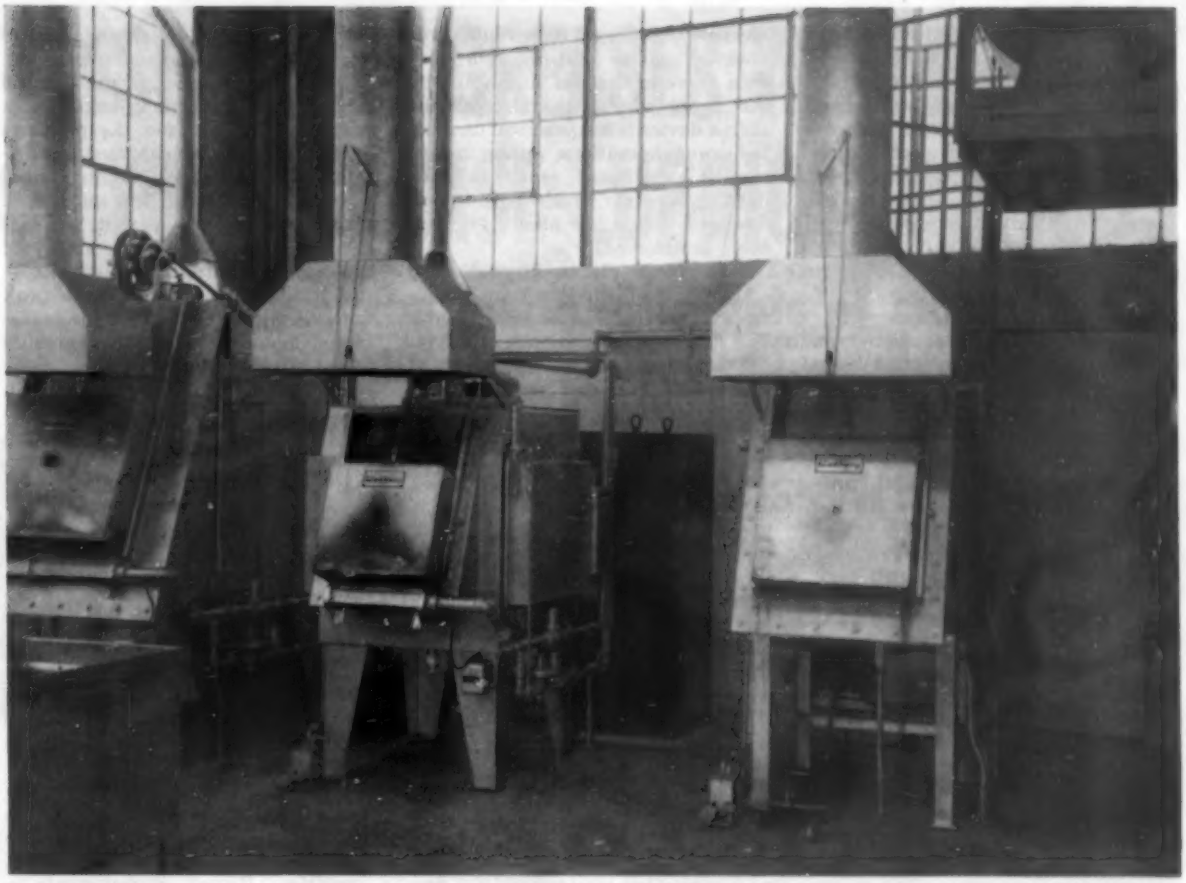
Costs

The initial cost of an industrial furnace is influenced by many factors, including the choice of energy source. In most comparable installations, the costs of the gas and electric furnaces are quite competitive though the electric unit may be slightly more expensive when the size and input rating of the furnace increase. It is true that, for any given case, the gas-fired furnace is generally larger than an electric unit of like capacity. The price of an electric furnace usually reflects the cost of expensive alloy heating elements.

The gas-fired furnace, on the other hand, deviates from a comparative norm only inasmuch as the increase in insulation and steelwork plus the price of relatively inexpensive burner equipment affects the furnace price. Exception to this comparison exists for those gas-fired furnaces which are to operate with a protective atmosphere; heat-resist-

APPROXIMATE STACK GAS LOSSES IN GAS-FIRED FURNACES

Furnace Temperature	Percent of Gross Input	
	Stack Loss	Available Heat
400 F	16 percent	84 percent
600	21	79
800	26	74
1000	30	70
1200	35	65
1400	40	60
1600	45	55
1800	50	50
2000	56	44
2400	67	33
2800	80	20



The box atmospheric furnace at left has metallic radiant elements; it can attain a temperature of 2000 F. The center furnace has ceramic elements and can develop 2500 F. The furnace at right is a convection furnace capable of 1400 F.

ant, metallic radiant tubes or ceramic gas-tight muffles generally force a higher first cost for the gas-fired furnace.

Of equal importance to the investment required for any furnace installation is the necessary allied equipment. It is not uncommon that the cost of the auxiliary equipment substantially exceeds the initial cost of the furnace itself. Considerable time should be spent in an investigation of the complete installation.

Probably the biggest single factor in the price analysis of an electric furnace is the need for an element transformer. As a general rule, they are not required in recirculating furnaces where the element is located in a separate chamber and cannot be touched by the operator or the work. A transformer is essential to the operation of smaller furnaces which feature the metallic radiant element; it is impossible to install sufficient element capacity at line voltage and still keep the element wire size within practical limits.

The same situation exists in multi-zoned furnaces where the physical space allotted to an individual control zone is too small to operate the elements directly from line voltage. As the size of the furnace increases, however, it becomes relatively easy to design elements for operation at 240 v. For the operation of ceramic resistors, a special and more expensive variable tap transformer is required to compensate for the increased resistance of aging elements.

The gas-fired furnace, while not burdened with the cost of a transformer, is dependent upon other secondary equipment. Essential to the functioning of the present day gas burner is a source of pressurized air (8 oz to 20 oz) and mixing equipment to properly proportion the gas and air going to the burner. The air supply may be provided by a single blower coupled to a furnace; if physical conditions permit, the output of a large blower may be manifolded to a group of individual units.

The choice of mixing equipment is usually influenced by the recommendations of the burner manufacturer, although most commercial proportioning devices can be used interchangeably. Also peculiar to the gas-fired furnace is the smoke exhauster to withdraw the fumes generated by the insertion of oily work pieces into the heating chamber. (Because of the contaminating effect of these fumes upon the electrical elements and the possibility of explosion, it is advisable to degrease oily work before processing it.

Further affecting the first cost of a furnace installation is the matter of temperature control and safety equipment. In this respect, both furnaces follow analogous paths though utilizing somewhat different instrumentation to effect the desired ends. A pyrometer for sensing temperature is absolutely essential to any furnace control system. This device telegraphs the needs of the furnace to the mechanism that in turn supplies the proper input to the unit. Any type of control from the simple on-off through to full proportioning can be had.

In its simplest form, the pyrometer

actuates the contactor of an electric furnace, through a relay, permitting power to flow to the elements. As the desired temperature is reached, the pyrometer de-energizes the contactor and the flow of electricity is shut off. In the gas-fired furnaces, the pyrometer similarly transmits its requests to a drive motor which actuates the gas control valve, opening or closing it as necessary.

Step Control

Since a simple two-position type of control gives rise to a rather large temperature band above and below the control setting, it is often necessary to use multi-step control or the almost straight-line control afforded by full proportioning. In full proportioning, a timing device (in the case of the electric furnace) is interposed between the pyrometer and the contactor; it regulates the percentage of operating time that the elements are energized. An anticipatory device within the controller provides regulation between 0 and 100 percent, depending upon the rate at which power is needed. The overall effect is to provide control void of peaks and valleys typical of the over- and under-shooting by step-type control.

Much the same performance is available in full-proportioning control of a gas throttling valve. Here, rather than obtaining an on-off ratio of input, the regulator selects a single fuel valve setting to maintain the desired conditions.

Safety Precautions

Safety precautions for an electric furnace are merely a matter of preventing the furnace temperature from exceeding the design limits of the equipment. As a rule, all that is needed is a simple device capable of shutting off the furnace when a predetermined temperature has been exceeded. This is relatively inexpensive insurance against the loss of valuable equipment and costly down-time occasioned by the overheating of a furnace.

In the gas-fired furnace, a hazard even greater than furnace overheating results from the explosive potential of unburned gas-air mixtures. For this reason, it is essential to safe operation to provide for positive indication of an ignition flame at the burner plus means of shutting off the gas-air supply in the event that such ignition has been extinguished. Normally, this is done by means of an electrode inserted into the burner at the point of junction between the pilot and the main flames. The sensing qualities of the electrode, through its circuit, provide immediate shut-off of a solenoid valve in the gas supply line in the event of flame failure. While such a device is not practical on multi-burner operations, other means can be substituted (such as safe-lighting cocks) which permit full flow only after the pilot flame has been established.

Like most pieces of industrial equipment, a furnace is known more for its upkeep than for its first cost. The furnace rarely changes the visual appearance of the piece being processed. For this reason, it is sometimes looked upon with skepticism and close scrutiny is kept on its operating cost.

As a general rule, the efficiency of an electric furnace is directly dependent upon the amount of heat that is lost through furnace walls, through door openings, or is transmitted to the outside by means of conduction along metallic paths extending through the furnace walls. In the case of atmosphere-type furnaces, a certain amount of sensible heat is carried from the furnace chamber by the outgoing protective atmosphere gases.

Flue Loss

While the gas-fired furnace is saddled with these same losses, it is also burdened with losses from the flue gases leaving the furnace at a temperature equal to or higher than the operating temperature of the furnace. The amount of heat lost in the flue gases varies from about 35 percent of the total heat input at 1200 F to about 70 percent at 2700 F.

For any given operating temperature and any given load, the difference in Btu input between the gas-fired and electric furnace will be that necessary to make up for the flue losses of the gas-fired unit. In general, this would indicate that high-temperature operation may be more expensive with gas than with electricity, while the reverse may be true at low temperatures.

Firing Intervals

When studying the energy costs of various units, consideration must be given to secondary features which influence the desirability of either source. With the exception of electric furnaces having an input proportioned by stepless control of a costly saturable reactor, the full input of an electric furnace's control zone is impressed upon the heating elements whenever that particular zone is energized. This requires that the wiring and control equipment be of ample size to handle the full rated input. It further dictates a study of existing electric demand rates.

With the exception of the demand charge, much the same is true of a gas supply. Here, too, the pipelines and mixing equipment must be capable of handling an uninterrupted flow of energy at the maximum rated capacity of the unit. Of significance, however, is the ability of the gas-fired furnace to easily throttle its demands during those peak periods when the demand for maximum input would put a hardship upon adjacent equipment or communities. Since the year-round availability of gas in many sections of the country is still uncertain, it behooves plants in such sections to provide for standby oil burning equipment to prevent costly shutdowns of their furnace equipment.

Maintenance

The maintenance of an industrial furnace is in general a function of the manufacturer's ability to build a sound unit and the complexity of its design. No furnace can operate without a good, sound maintenance program and it is the wise company that plans preventive maintenance.

Specifically, the electric furnace has a more critical problem since its item of highest maintenance — the heating element—is the heart of its operation. Recent improvements in design of these elements have done much to increase the life expectancy to a point where the greatest cause of failure results from foreign particles shorting across the heater.

Failure of combustion chamber refractories under the intense heat and erosion of the burner accounts for the greatest portion, by far, of the maintenance of a gas-fired furnace. The failure is gradual and can be detected by an observing maintenance man long before failure occurs.

Though the replacement of heating elements and the rebricking of a combustion chamber are far from being the only major maintenance problems encountered with present-day industrial furnaces, they are quite representative of the basic differences between electric and gas-fired furnaces.

Merits of Furnaces

It rests with the user to evaluate the relative merits of furnaces as they affect his particular needs. Experience with previous equipment will have much to do in the establishment of a preference. It should be remembered that more furnaces have failed because of misapplication than because of inability to perform the job for which designed.

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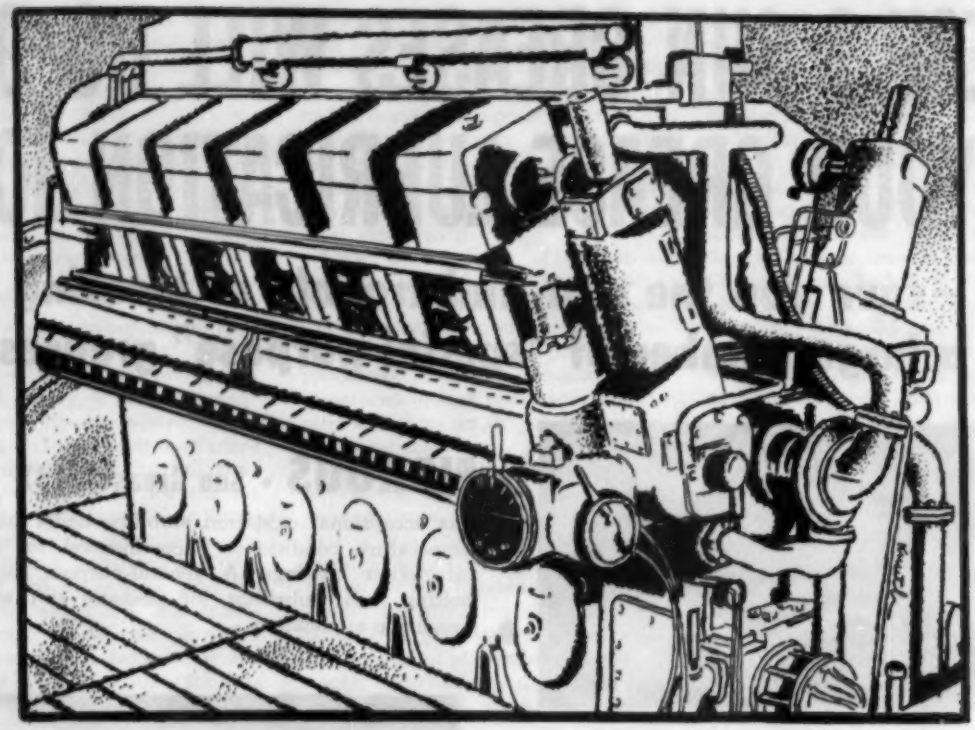

Miller System Ups Diesel Output

RALPH MILLER, Consulting Engineer

THE MILLER SUPERCHARGING System is a method of utilizing the high output turbochargers available today to supercharge two and four stroke cycle diesel engines. The method has resulted in the successful increase of the specific output of an engine, without exceeding its safe thermal load.

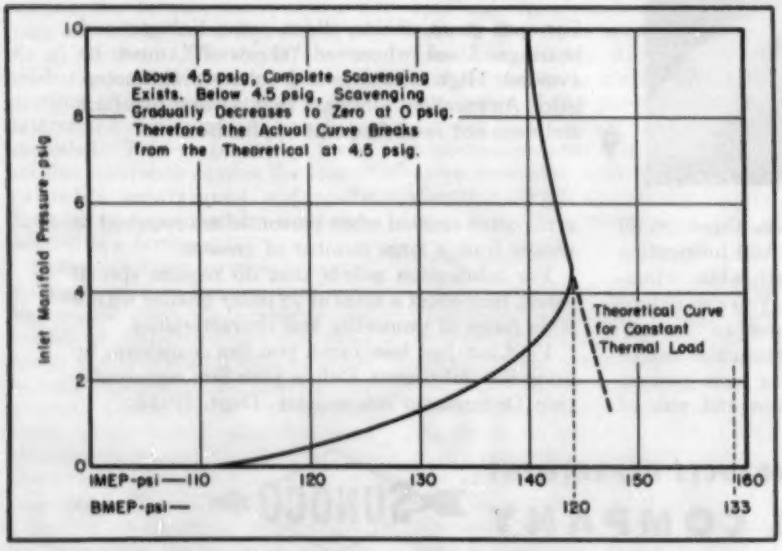
Above 4.5 psig, Complete Scavenging Exists. Below 4.5 psig, Scavenging Gradually Decreases to Zero at 0 psig. Therefore the Actual Curve Breaks from the Theoretical at 4.5 psig.
Theoretical Curve for Constant Thermal Load
Inlet Manifold Pressure - psig
0
2
4
6
8
10
IMEP-psi — 110 120 130 140 150 160
BMEP-psi — 120 133

Fig. 1. In heavy duty, continuous type service, a Buchi turbocharged engine can be rated at 120 psi BMEP with an inlet manifold pressure of 4.5 psig.

Early experience with turbocharging showed that for continuous, heavy duty service, the thermal load on the engine — that is, the temperature of the rings, piston crown, cylinder liners, and other parts — was the factor limiting the output of the engine. The problem was partially solved by blowing air through the clearance chamber when the piston was at or near the top dead center position on the exhaust stroke. The scavenging air cleared out residual exhaust gases from the previous stroke and removed heat from the metal parts. Turbocharging the inlet manifold is known as the Buchi System of supercharging. Further experience with a Buchi turbocharged engine showed that for the heavy duty, continuous type service, an engine could be rated at a brake mean effective pressure (BMEP) of 120 psi, with an inlet manifold pressure of 4.5 psig. (see Fig. 1).

More power can be extracted from

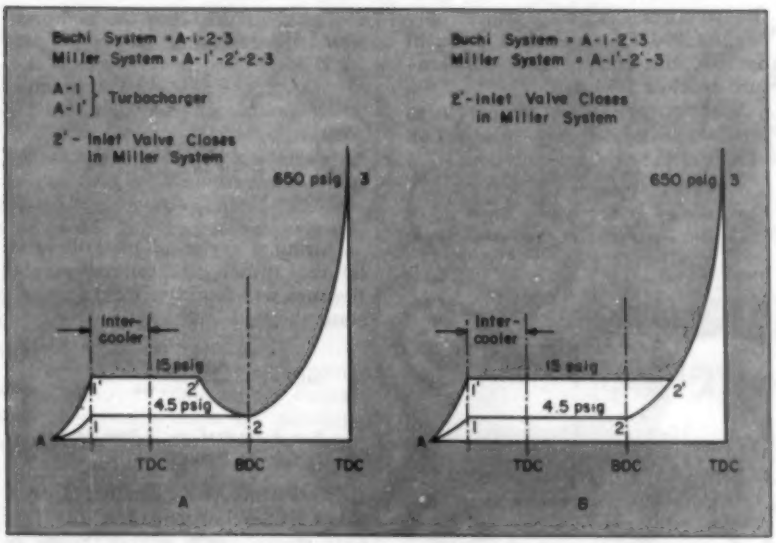

Fig. 2. Each of the two methods of applying the Miller Supercharging System are shown graphically superimposed over the Buchi Supercharging System.

the engine at the same thermal load if the compression temperature can be lowered and more fuel allowed to enter and burn in the cylinder. The equation for determining the compression temperature is:

$T_2 = T_m \times R^{n-1}$ where:

T_2 = Compression Temperature

T_m = Inlet Manifold Temperature

R = Compression Ratio (Volume)

n = Compression Exponent

One method of decreasing the compression temperature (T_2) is to decrease the inlet manifold temperature (T_m). This can be done by placing an intercooler between the turbocharger outlet and the inlet manifold. Laboratory experiments have verified the theoretical calculations, but because of the temperature of the available cooling water at the majority of field installations, the practical limit to intercooling is to about 100 F inlet manifold air temperature. Nevertheless, by intercooling the Buchi engine, the brake mean effective pressure (BMEP) has been raised from 120 psi to 133 psi for continuous, heavy duty service conditions.

Compression Ratio

Another method of reducing the compression temperature (T_2) is to reduce the compression ratio (R). It is obvious that the compression ratio cannot be reduced by increasing the clearance, since this would also reduce the expansion ratio and thereby decrease the thermal efficiency. However, the compression ratio can be reduced without decreasing the thermal efficiency if the inlet valve is closed before the cylinder is completely charged, or, if the inlet valve is allowed to remain open after bottom dead center of the inlet stroke so that some of the fresh charge can be forced back into the inlet manifold. The greater weight per unit volume of high pressure supercharged air more than compensates for the slightly reduced displacement volume in the cylinder. This method of controlling the compression temperature is one important feature of the Miller Supercharging System.

The previously used equation for the compression temperature can also be expressed as:

$$T_2 = T_m \times \left[\frac{P_2}{P_m}\right]^{\frac{n-1}{n}}$$

Because $\left[\frac{P_2}{P_m}\right]^{\frac{1}{n}} = R$

P_2 = Compression Pressure

P_m = Inlet Manifold Pressure

This is another way of saying that if the compression ratio (P_2/P_m) can be reduced by increasing the inlet manifold pressure (P_m), the compression temperature (T_2) can be reduced without a reduction in compression pressure.

Fig. 2 illustrates two methods of applying the Miller Supercharging System, with both methods graphically superimposed on the Buchi Supercharging System. In 2A, the Miller System uses the intercooled high pressure air from the turbocharger and intercooler to prime the cylinder at 15 psig and 100 F. The inlet valve is closed before the suction stroke is completed, thus allowing the cylinder charge to expand to 4.5 psig, and, in expanding, cool to 35 F at bottom dead center (BDC). The charge is then compressed, as in the Buchi engine, to 650 psig. But in the Miller System,

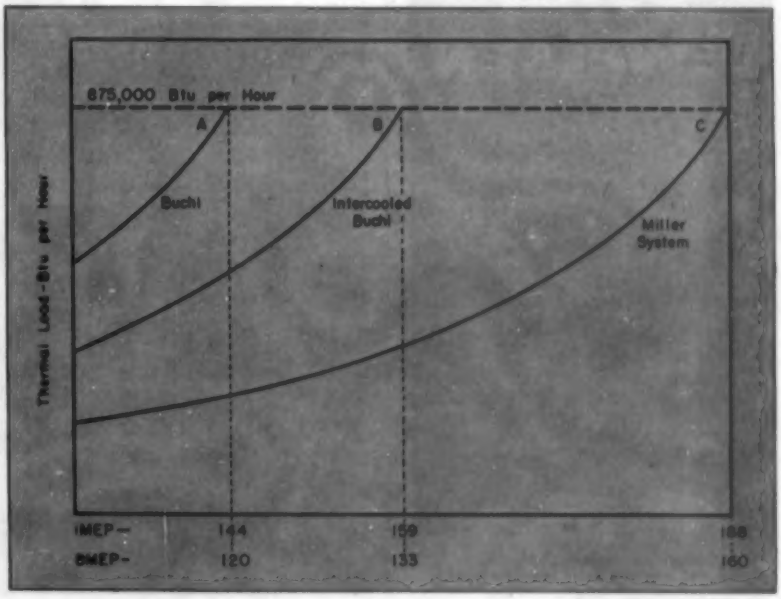

Fig. 3. These curves were plotted for the three types of supercharging systems showing relationships between mean effective pressures and thermal loads.

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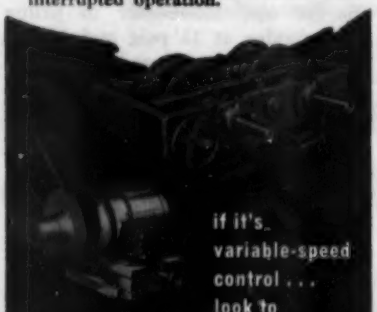

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the compression temperature only reaches 900 F, while in the Buchi System, the compression temperature reaches 1080 F.

The compression temperatures can be calculated by substituting values in the original equations:

m = Manifold Conditions

1 = Conditions at BDC of Inlet Stroke

2 = Conditions at TDC of Compression Stroke

then: $T_1 = T_m \times \left[\frac{P_1}{P_m}\right]^{\frac{n-1}{n}}$ =

$\left[100 + 460\right]\left[\frac{4.5 + 14.7}{15 + 14.7}\right]^{\frac{1.4-1}{1.4}} - 460 = 35\,F$

$T_2 = T_1 \times \left[\frac{P_2}{P_1}\right]^{\frac{n-1}{n}}$ =

$\left[35 + 460\right]\left[\frac{14.7 + 650}{4.5 + 14.7}\right]^{\frac{1.4-1}{1.4}} - 460 = 900F$

T_2 When Operating on Miller System = 900F

For the Buchi Engine: $T_2 = T_1\left[\frac{P_2}{P_1}\right]^{\frac{n-1}{n}}$

$= \left[100 + 460\right]\left[\frac{650 + 14.7}{4.5 + 14.7}\right]^{\frac{1.4-1}{1.4}} - 460$

$T_2 = 1080\ F$

Second Method

The second method of applying the Miller System is shown in Fig. 2B. The inlet valve is held open past bottom center (BDC) of the inlet stroke. The net compression ratio is reduced because compression starts at a higher initial pressure (15 psig). The final compression pressure is the same as before, 650 psig. In this case the compression temperature is:

$T_2 = T_m\left[\frac{P_2}{P_m}\right]^{\frac{n-1}{n}}$

$= \left[100 + 460\right]\left[\frac{650 + 14.7}{15 + 14.7}\right]^{\frac{1.4-1}{1.4}} - 460$

$T_2 = 900\ F$

During a series of tests directed by the author, the following relationship was found to exist for constant thermal load:

$$IMEP = C \times \frac{P_2^{.383} \times P_3^{.276}}{T_2^{1.352}} *$$

C = A Constant for a Given Engine

P_3 = Firing Pressure

These tests were conducted on a 6 cyl. supercharged 13 x 16½ in., four stroke cycle engine. Some of the results of the tests are plotted on Fig. 3. Curve A was the first test run and forms the basis for all the tests. On this particular engine, the thermal load at the Buchi rated load of 120 psi brake mean effective pressure was 875,000 Btu/hr released to the water jackets from

*For a derivation of this equation, see an ASME paper entitled, "The Effect of Charge Temperature and Pressure on Rating of Diesel Engines and a Variable Compression Ratio Supercharging System for 2 and 4 Cycle Internal Combustion Engines" by the author presented at the Oil & Gas Power Conference, Dallas, Texas, June 25-29, 1951.

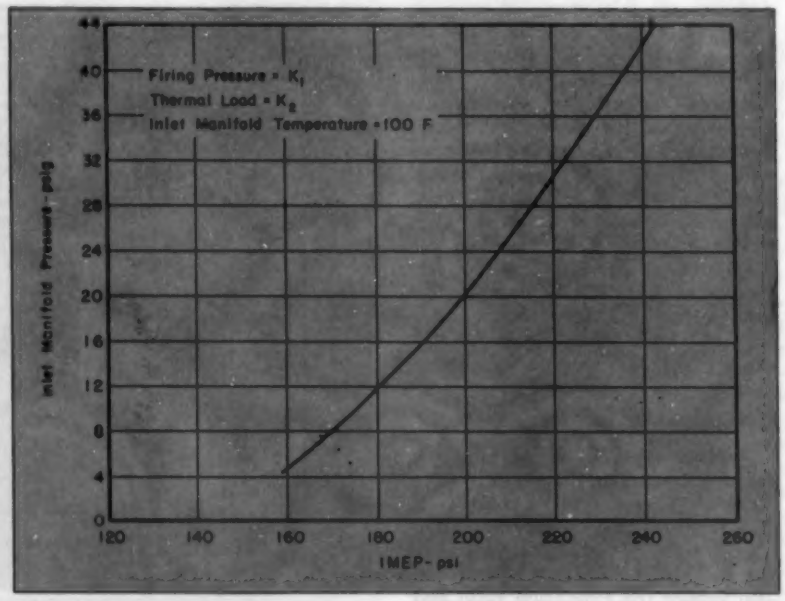

Fig. 4. As better turbochargers are developed and the inlet manifold pressure can be raised, the IMEP will increase rapidly as shown by the curve.

the cylinders. With this heat release as the maximum thermal load, tests B and C were run. Test B is the intercooled Buchi System where the inlet manifold air is cooled to 100 F after leaving the turbocharger. Curve C shows the engine set up to run on the Miller Supercharging System with an inlet manifold pressure of 15 psig and a temperature of 100 F. Under the latter conditions, the engine ran at a brake mean effective pressure of 160 psi with the same thermal load as the Buchi engine was operated at.

The next obstacle to be overcome is the manufacture of higher output turbochargers. With a few elementary thermodynamic manipulations, the relationship between indicated mean effective pressure and the turbocharger discharge pressure at constant thermal load on the engine can be found from the following equation:

$$IMEP = C \times \frac{P_2^{.383} \times P_3^{.276}}{T_2^{1.382}}$$

$$\frac{P_2^{\frac{n-1}{n}}}{T_2} = \frac{P_m^{\frac{n-1}{n}}}{T_m}$$

$$\frac{n-1}{n} = \frac{1.4-1}{1.4} = .285$$

$$\frac{P_2^{.285}}{T_2} = \frac{P_m^{.285}}{T_m}$$

$$\frac{P_2^{.385}}{T_2^{1.382}} = \frac{P_m^{.385}}{T_m^{1.382}}$$

$$IMEP = C \times \frac{P_m^{.385}}{T_m^{1.352}} \times P_3^{.276}$$

Assuming that the manifold temperature and firing pressure remain constant, the indicated mean effective pressure is proportional to the inlet manifold pressure raised to the power .385 ($P_m^{.385}$). This relationship is shown in Fig. 4.

Better Turbochargers

Recently, efficient turbochargers with a discharge pressure of 30 psig have become available. One of these turbochargers is being tested on an engine running on the Miller Supercharging System with very good results. From the above equation, the rated brake mean effective pressure of this engine is:

$$188 \times \left[\frac{30+14.7}{15+14.7}\right]^{.385}$$

$$= 219 \text{ psi} \quad \text{or}$$

$$BMEP = 219 - (188-160)(219/188)^{.5}$$

$$= 190 \text{ psi}$$

As turbochargers are developed with higher discharge pressures, further gains can be expected in the specific output of diesel engines without exceeding their safe thermal load or rating.

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ideas in action

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Philadelphia Electric Plans Modern Steam Plant

In 1950 Westinghouse Electric Corp. developed the inner-cooled generator using hydrogen as a cooling agent circulated through stator and rotor windings in direct contact with conductors. The first completely inner-cooled generator (rated at 100,000 kw) was installed at Buffalo, N. Y. for Niagara Mohawk Power Corp. early this year. In the last month another stride forward in the turbo-generator field was made with an order to Westinghouse for a 275,000 kw inner-cooled unit to be used by Philadelphia Electric Co.

The unit will be installed in the new power generator station planned to augment power for the rapidly growing Delaware Valley. The new plant, which will add more than 10 percent to the present capacity of PEC, will establish new "highs" for efficiency, steam pressure, and temperature according to R. G. Rincliffe, president of PEC.

The steam generator, to be built by Combustion Engineering, Inc., will supply steam to the turbine at the highest pressure and temperature of any existing or proposed power plant in the world—5000 psi and 1200 F—although initial operation will be at 1150 F.

The tandem-compound, four-cylinder turbine will operate at 3600 rpm, utilizing triple-flow exhaust to the condenser, and double reheat. Both reheats will be to 1050 F. All elements of the turbine except the super-pressure element are of conventional design using ferritic materials. The super-pressure element will be designed for initial steam conditions of 5000 psi and 1200 F, exhausting at about 2400 psi.

Hydrogen at 45 psi will cool the generator rated at 352,000 kva, 3 phase, 60 cycle, 24,000 v, 3600 rpm.

Combustion Engineering, which last year acquired the American license rights to designs and patents of Sulzer Bros., Ltd. of Switzerland, will furnish a Sulzer Monotube boiler of the super-pressure "once-through" type employing forced circulation. Maximum design steam conditions for the boiler are 6000 psi and 1200 F. At rated load, primary steam flow will be 1,540,000 lb per hr. In the first stage of reheat, steam at 1050 psi will be reheated to 1050 F. Conditions for the second stage of reheat will be 250 psi, 1050 F.

Of the total heat transferred in the boiler, more than 65 percent will be absorbed in the superheater and the two reheaters. To accomplish this, radiant-wall type superheating surface will supplement the conventional suspended sections.

Although conventional combustion controls will be employed to meter fuel and air in proportion to steam demand, for control of steam and water flow and temperature in the boiler, Sulzer oil hydraulic automatic controls will be used.

For a more complete discussion of the advanced engineering incorporated in this new plant see I&P, Jan., 1954.

More Power at Less Cost

Savings up to 75 percent in operating costs for the University of Oregon building, at Eugene, are realized by using sawdust and hogged wood from nearby sawmills as fuel for this modern generator station and heating plant (left). Waste material is trucked in from mills within a 10-mile radius of the plant, stockpiled, and then pushed or loaded into the hopper by this International Harvester TD - 9 crawler equipped with a Drott Skid-Loader.

At the Colson Corp. plant in Elyria, Ohio (right) a capacitor installation is saving the firm $300 monthly in power costs. The units, totaling 450 kwa, corrected the power factor from 84 to better than 95 percent, eliminated the need for rewiring and additional electrical equipment. Photo shows one capacitor installation in the truck shop.

Joint Agency Will Coordinate Nuclear Engineering Activity

To meet "the pressing problems of nuclear engineering and the related sciences" Engineers Joint Council has taken initial steps toward organizing a joint agency to enlist cooperation of all engineering groups and scientists in discussions of nuclear engineering subjects and publication of worthwhile papers and addresses.

EJC, made up of engineering societies with a total membership of 170,000, will extend an invitation to the societies of physicists and chemists to join the engineers in planning a strong organization, according to Warren L. McCabe, Administrative Dean at Brooklyn Polytechnic Institute, chairman of the EJC Committee on Recognition of Specialties in Engineering. A national convocation in 1955 is contemplated for discussion of nuclear development for industrial use.

NICHOLSON

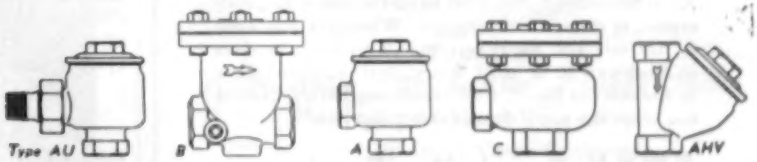
Steam Traps feature

LESS parts

MORE capacity

Note the extreme simplicity of Nicholson industrial steam traps. The heavy-duty bellows integral with valve is the only moving part -- a substantial factor in their low maintenance cost. See also the larger valve orifice. This noteworthy feature results in Nicholson's 2 to 6 times average drainage capacity.

A recent survey showed the features following also to be reasons why plants with standardization-for-economy programs are increasingly adopting Nicholson traps: (1) Operate at lower temperature differential; fast action keeps equipment full of live steam; higher temperatures. (2) No air-binding; eliminate costly fluctuation of operating temperatures. (3) Freeze-proof; freely installed outdoors. (4) No need to change valves for varying operating pressures. (5) Record for low steam waste; as little as 1%.



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Hundreds of Uses This principle can be used in dozens of ways around both plant and home. By expanding hard and tight within a repair, Smooth-On IRON Cement stops leaks, fills holes and seams in any metal, patches boilers, repairs water jackets and radiators, corrects wobbly bolts and screws, plugs tanks, holds loose parts tight — in fact, does all kinds of things where that combination of strength and expansion can be used. Smooth-On IRON Cement never tires, or softens from age. Years after a repair is made the Smooth-On will be found harder, tighter, stronger.

Keep Smooth-On No. 1 on hand for that emergency repair. It does not deteriorate. Whenever you need it, just mix and fix. It sets in half an hour, hardens to Rockwell R-70 in 24 hours. And of course there is Smooth-On No. 2, a slower-setting IRON Cement but with the same dependable properties.

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SMOOTH-ON
THE IRON CEMENT OF MANY USES
Circle 549 on Reply Card for more data

ideas in action

—Starts on page 92

Analyzer Lowers Operating Cost For Spark-Fired Gas Engines

At the Kaiser Aluminum and Chemical Corporation's Chalmette, La. plant, two buildings with 40 engines each generate power required to produce aluminum in two of the plant's eight-pot lines. Engines are Nordberg 11-cylinder with 14-in. bore and 16-in. stroke, rated at 1820 hp.

An installation of this size, to be as economical as possible, necessitated a new method of engine supervision. In a paper presented before the ASME Oil and Gas Power Conference, J. E. Hart, technical superintendent at Kaiser, and E. A. Sammis, senior engineer at Sperry Gyroscope Co., gave an account of how the

Kaiser engineer uses camera to make a photo record of Sperry analyzer checkup on an engine at aluminum plant.

Sperry Engine Analyzer has been used at Kaiser to insure higher efficiency and lower engine maintenance.

In this adaptation for industrial use, the analyzer brings a new technique of balancing cylinder output — with all cylinders pulling a maximum safe level — while providing a sure means of visual checkup on operating adjustment and service needs. The analyzer facilitates quick and accurate adjustment during operation by indicating operating conditions of the ignition system and of engine events that involve impact.

Filters Cut Maintenance Costs and Reduce Fire Hazards

Space heaters in shop areas tend to be "catch-alls" for oil and dust. To maintain these units at high efficiency, they must be dismantled and cleaned with steam several times a year. At the Timken Roller Bearing Co. shops at Canton and Gambrinus, Ohio it was necessary to repeat this operation three or four times a year at a cost of about $75 per cleaning per heater. With a total of some 100 unit heaters to maintain, the maintenance cost became formidable.

This expensive and time-consuming maintenance problem has been solved by installing two permanent impingement type air filters at the back of each space

heater. The two filters can be removed periodically, placed in a washer, and in a matter of minutes, reinstalled in the sheet-metal housing.

Total cost for the sheet-metal housing, the filters, and the time required to install them is figured at $125 per heater. At this rate the filter installations will pay for themselves in less than a year as a result of the marked reduction in maintenance.

Filters also solved the problem of carbon particles and oil that deposited in the ducts and smoke stacks, creating a potentially dangerous fire hazard. Each duct and smoke stack was laboriously cleaned yearly by the maintenance crew. The filters, similar in type to those installed on the space heaters, have eliminated the yearly cleaning and reduced the fire hazard.

New Materials and Techniques Explored at Magnet Laboratory

To provide magnet users with magnetic field energy in the most efficient manner possible, Carboloy Dept. of General Electric Co., Detroit has equipped its new laboratory with every type of modern equipment known for measuring magnetic fields.

Facilities enable engineers to check designs, measure performance and efficiency of equipment in which Carboloy products are used, establish standards, calibrate precision magnetic assemblies, and evaluate new magnetic materials.

The laboratory is also the hub of activities for the Department's new permanent magnet manufacturing

Top left, recording hysteresigraph with amplidyne generator; top right, capacitor discharge impulse magnetizer; lower left, oscillograph records Thermistor test performance; lower right, production line test equipment.

plant in Edmore, Mich. and the development foundry in Detroit, Mich. Customer requirements are analyzed in the laboratory, and expressed to the factory in terms of manufacturing instructions. The laboratory will also work in cooperation with the company's research labora-

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Profit Two Ways With....

WILSON Condenser Tube Inserts

1 Put Equipment Back on Line Faster

You save man-hours and money with new Wilson Condenser Tube Inserts because they eliminate the need to plug off leaking condenser or heat exchanger tubes. Wilson Inserts go in fast...need no cementing... take less time than it does to plug a "bad tube". What's more, these highly efficient inserts put the tube back into operation as in the original design.

2 Multiply Service Life of the Tube

In many cases, condenser tubes usually fail within the first few inches of the inlet. Wilson Condenser Tube Inserts actually restore these leaking tubes to service by sealing the deteriorated portion of the tube. Wilson Inserts also retard or eliminate the effect of inlet end erosion.

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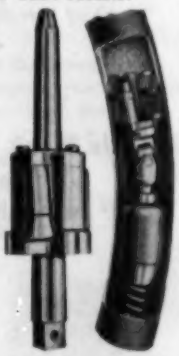

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ideas in action

—Starts on page 92

tories in Schenectady to further the development of new magnetic materials and techniques.

Installations required to do this engineering work include magnetizing and demagnetizing equipment, stabilized power supplies, basic machine tools to allow construction of magnetic circuit components, automatic equipment for recording hysteresis loops, and facilities for developing high speed test equipment for production line use (lower right).

A recording hysteresigraph (top left) automatically makes a complete and accurate record of a magnet's entire hysteresis loop. Any or all parts of the major or minor loops can be explored at will by the operator. The magnet's performance may be thusly recorded for future use in design work done by application engineers.

Another important instrument is a 3000-v capacitor discharge impulse magnetizer (top right), for magnetizing odd-shaped single large magnets or magnetic assemblies. A standard welding power unit, mounted near a bank of 15, 3000 v 120-microfarad capacitors, controls power for the magnetizer.

One section is reserved for experiments with Thermistors (lower left). Facilities here include a controlled temperature oil bath equipped with both heating and refrigeration units.

The laboratory's power is furnished by a separate sub-station containing special motor-generator sets and rectifiers for controlled direct current and alternating current at varied frequencies.

Government Publishes List of Inventions and Problems for Industry

The Federal Government spends something over $2 billion each year to support research and development projects (see "An Idea Mine," *Consulting Engineer*, May, 1954). The question is how to make the products of this technical research easily available to industry.

Under the joint sponsorship of the Department of Commerce and the Small Business Administration, the first of a series of seven proposed books on government-owned inventions is now available — *Instrumentation*. It lists 775 inventions in the field of instrumentation — gives a brief description of each, the patent number, inventors' names, and the government agency administering the patent.

Dr. Archie M. Palmer, chairman of the Government Patents Board, points out that most of these inventions are available on a royalty-free license basis.

Instrumentation (order No. 11464) may be purchased at $2.00 a copy from Offices of Technical Services, U. S. Department of Commerce, Washington 25, D. C. (Room 6227, Commerce Bldg.).

At the other end of the scale is a publication of the National Inventors Council, U. S. Department of Commerce — "Technical Problems Affecting National Defense List 1954." This bulletin lists specific needs of the military services — everything from lightweight equipment for translating speech into writing to a substitute for wolverine fur. Copies may be obtained free of charge by writing to National Inventors Council, U. S. Department of Commerce, Washington 25, D. C.

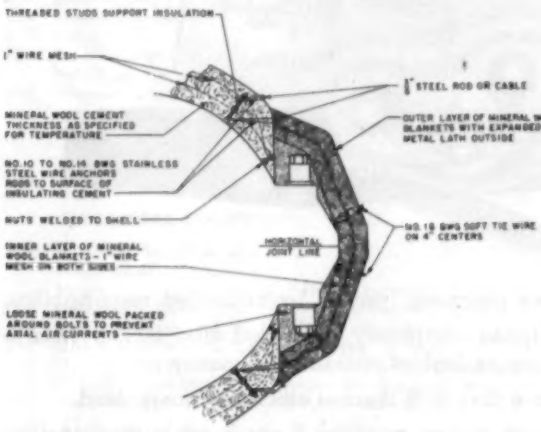
Blanket Insulation Solves Problem of Excessive Turbine Down-Time

Removing and replacing thermal insulation on horizontal flanges — a problem faced each time a turbine is inspected internally — is expensive in terms of man-hours involved and reduced operating capacity while the turbine is out of service.

Two types of insulation are in common use. Probably the most widely used technique is to cover the entire turbine shell and flanges with a plastic material such as mineral wool cement in thicknesses from four to nine inches. This means that to remove the upper turbine shell for inspection, the hardened insulation must be knocked away from nuts and bolts joining the flanges and from the flanges themselves. As much as several days may be required to reapply the cement after inspection and repair are completed.

In the second method, flanges are boxed-in by sections of block insulation cut to size and wired in position. The cracks are filled with insulating cement and then a cement finish applied over the entire covering. Removal of this type of insulation is quicker and easier, but it is equally difficult and time-consuming to replace, and much of the insulating material is lost at each inspection.

To cope with these problems, the Industrial Mineral Fiber Institute, Inc. of New York has developed a blanket method of turbine flange insulation said to


THREADED STUDS SUPPORT INSULATION
1" WIRE MESH
1" STEEL ROD OR CABLE
MINERAL WOOL CEMENT THICKNESS AS SPECIFIED FOR TEMPERATURE
OUTER LAYER OF MINERAL WOOL BLANKETS WITH EXPANDED METAL LATH OUTSIDE
NO.10 TO NO.16 BWG STAINLESS STEEL WIRE ANCHORS RODS TO SURFACE OF INSULATING CEMENT
NUTS WELDED TO SHELL
NO.18 BWG SOFT TIE WIRE ON 4" CENTERS
HORIZONTAL JOINT LINE
INNER LAYER OF MINERAL WOOL BLANKETS - 1" WIRE MESH ON BOTH SIDES
LOOSE MINERAL WOOL PACKED AROUND BOLTS TO PREVENT AXIAL AIR CURRENTS

Blanket insulation is removed by cutting tie wires to steel rods and those to the metal lath facing on the outside.

require only a fraction of the time for installation and removal required for either of the other methods. In addition, the insulation material can be reused.

As in the other two methods, the turbine shell itself is covered with insulating cement but is beveled down on both sides of the flange. Mineral wool blankets, usually the 24 x 96 in. size, are cut and shaped to fit over the flange and are secured with soft tie wires to steel rods on either side, as shown in the drawing. The two layers of insulation used — totaling 5½ in. — are as effective as the 9 in. maximum cement thickness commonly specified.

Removal is effected simply by cutting the tie wires to the steel rod and those attached through the insulation to the expanded metal lath facing on the outside. When inspection is completed, new tie wires are attached and the same blanket sections wired back in place.

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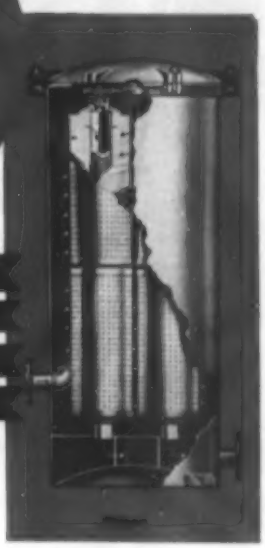

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readers' guide

. . . an index to advertised products

The table below lists, according to product groupings, all equipment advertised in this issue. To request more data, circle key numbers on Reply Cards, pages 34/35 & 98/99

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How to protect electric systems from lightning

a practical guide showing best methods

Just Out

Here are the ways to avoid annoying and costly shutdowns from lightning! This new book shows you—in simple and easy to follow form — best methods in use of lightning arresters, in shielding, and in grounding lightning. With a minimum of math and theory, it gives you the means to early practical solutions of your lightning protection problems!

LIGHTNING PROTECTION FOR ELECTRIC SYSTEMS

By EDWARD BECK

Manager, Lightning Arrester Section Switchgear Distbn. Apparatus Eng., Westinghouse Elec. Corp.

310 pages, 6x9, 149 illus., $6.50

This clear and basic book points the way to fuller, surer lightning protection for electric systems and equipment. It shows the nature of lightning and its effects, various means of protection, how to select and apply arresters, and what conditions to look for to avoid trouble.

The author describes the different types of arresters, and explains the meanings of their ratings—along with their limitations. A special chapter covers the protective and follow current characteristics of lightning arresters for power and distribution apparatus, 2400 volts and higher, with a description of the characteristics, their significance, and test methods. You learn how to choose the type and rating of arrester for a particular job, how to locate, choose, and apply lightning arresters to protect power equipment, and how to use arresters in distribution apparatus.

Applications of arresters at high altitude, for protection of portable equipment, and other special jobs, are discussed, and the author includes a chapter on protection for secondary circuits and other low-voltage circuits. He discusses house circuits and control and signalling circuits.

The author gives a critical review of results of field research on the lightning arrester in service, and draws conclusions about the probability distribution of various characteristics. He discusses grounding — its importance as a link in protection from lightning, and also as a safety measure against high voltages caused by faults. The author backs his recommendations by explaining the fundamental behavior of traveling waves and how this influences the effect of lightning-protective devices.

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The Lunkenheimer Co.—Marvin L. Steinbuch succeeds **John W. Bolton** as chief metallurgist and research director upon the retirement of Bolton.

Fred H. Hehemann, chief engineer at Lunkenheimer Co., is observing his 50th anniversary with the company.

Steinbuch

Morris

The Kuljian Corp. has appointed **Richard G. Morris** to manager of its advertising and public relations program. He was formerly with the **Penn Industrial Instrument Corp. Herbert Askwith** continues as advertising and publicity consultant for Kuljian.

W. H. & L. D. Betz announces appointment of **Bernard F. Shema** as chief microbiologist to direct an extensive research and development program on improvement of industrial water conditioning techniques.

Chandeysson Electric Co. — Robert A. Embree is appointed process and plant engineer of the motor-generator division. He was formerly plant engineer for **Laclede Christy.**

The American Society of Heating and Ventilating Engineers and the **American Society of Refrigerating Engineers** have combined to form a Joint Committee on Cooperation consisting of five representatives from each Society: **Merrill F. Blankin; Peter B. Gordon; John E. Haines; Everett N. McDonnell; Prof. Elmer R. Queer,** representing ASHVE; and **Frank H. Faust; Prof. Carl F. Kayan; James Larkin; John F. Stone;** and **Nathan N. Wolpert** representing ASRE.

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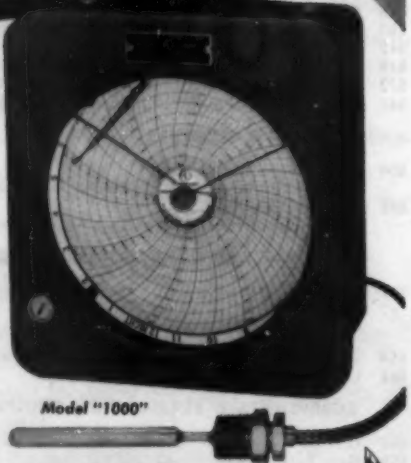

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TEMPERATURE RECORDERS

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American Steel & Wire Div. of U. S. Steel has promoted **John P. Debri** to a position in charge of special duties in the office of district manager of operations in Chicago. Succeeding Debri as general superintendent of the Joliet plant is **Joseph J. Just. Jacob W. Cox** moves up to the position of division superintendent, blast furnaces at the Joliet plant.

Division superintendent of power and fuel at U. S. Steel Corporation's Gary Steel Works is **John T. Seaman.** He succeeds **Arnold J. Beyer,** who was recently promoted to chief engineer at the Gary Works.

Dressen-Barnes Corp. appoints **B. F. McNamee** as chief of research and development of motor controls and power supplies.

Jones & Laughlin Steel Corp. names **A. A. Archibald** as vice president—engineering and plant, and **F. T. Barton** as vice president — special products and services.

Germany **Harju** **Klees**

GHK Associates, Engineers, Industrial Consultants, and Designers is the name of a new firm to be headed by **John B. Harju** as executive director. **Octavius Germany** and **Richard Klees, Jr.** are his associates. Address is the Garfield Bldg., 4612 Woodward Ave., Detroit, Mich.

Combustion Engineering Inc. appoints as district manager of the Los Angeles office **Warren L. MacDonald**

Anaconda Wire & Cable Co.—William O. Riley is promoted to superintendent of the newly expanded mill at Orange, Calif. **Charles M. Thomas** succeeds Riley as assistant superintendent of the mill at Anderson, Ind. **Ray Clevenger** becomes technical supervisor at Anderson, and **Carl Eckstein** is named assistant head inspector.

Bell & Gossett Co. announces four new vice presidents: **W. A. Boone,** who also becomes assistant treasurer; **H. A. Lockhart,** who also continues as chief engineer; **R. A. Marquardt,** assistant secretary and comptroller; and **C. R. Smith.**

Babcock & Wilcox Co., Boiler Div. appoints **E. B. Severs** as development engineer in the Erection Dept.

Massachusetts Institute of Technology—Dr. Jacob P. Den Hartog is appointed head of the department of mechanical engineering.

Murray Iron Works Co. announces appointment of The Pipework and Boiler div., Mac Isaac and Menke Co. as western representative.

You can avoid motor burnouts

THE temperature surrounding motor protection equipment is an important factor in motor burnouts. In order to prevent nuisance stoppages in hot weather, the rating of protective equipment is often raised. Then, when plant temperature drops, protection is inadequate . . . motors are more subject to burnout.

This explains why an ever-increasing number of plants are standardizing on HEINEMANN Circuit Breakers as manual motor controllers. Set tripping points of HEINEMANN Circuit Breakers *are completely independent of ambient temperature.*

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bulletins

. . . for listing of the bulletins just received see page 36

AIR CLEANING & DUST COLLECTION

250—Small Scale Dehydration

To meet the increased demand in engineering operations for small volumes of dry gases not warranting plant size installation, this company has developed the Hydryer, described in seven-page booklet. J. F. Pritchard & Co., Equipment Div.

251—Dust Collectors and Arrestors

Series of four folders describes cyclone type collector and portable, standard, and automatic bag-type dust arrestors. Also includes 32-page catalog describing exhaust fans for dust collecting and air handling. Northern Blower Co.

252—Industrial Dusts

"The Collection and Recovery of Industrial Dusts," 32-page manual 101, discusses various types of dust and techniques used in analysis, lists the factors which influence choice of equipment, and explains the operation of each type of collector. Buell Engineering Co., Inc.

253—Precipitation Equipment

Engineers contemplating the installation of equipment for recovering dusts, fly ash, fumes, mists, fogs, or other similar suspensions in stack or process gases will find much valuable data in this 40-page booklet. Western Precipitation Corp.

254—Electrical Precipitators

Booklet 2-ATC covers the history and fundamentals of electrical precipitators, design and construction, dimensions and capacities, electronic power supply, selenium power supply, and installation stories. Provides an up-to-date discussion with illustrations of latest developments. The Aerotec Corp.

255—Tubular Dust Collectors

Booklets 2-PDC and 3-PDC on mechanical dust collectors cover capacities and efficiencies, dimensions, construction and the decantation method used on installations where re-injection of large, unburned high carbon particles is required for economical operation. Prat-Daniel Corp.

256—Industrial Dusts

Booklet 3-TTC gives a brief background of modern dust problems and an approach to their solution. Discussed are sources of dust, determining dust size, prediction, fly-ash emission codes, types of dust and methods of control. The Thermix Corp.

257—Dust and Fume Removal

This 19-page bulletin, 610, pictures and describes the standard units that go to make up the Multi-Wash System for the removal of air-borne dust, fumes, vapors, and odors. Besides explaining the operation and advantages of each component of the system, the booklet includes many photographs. Claude B. Schneible Co.

371—Dust Collectors

Dust collectors, including cyclone, wet or dry dynamic, and cloth screen arrestor types are the subject of a 32-page bulletin. Uses of air conditioning, ventilating, conveying, drying, and cooling units are presented. Kirk & Blum Mfg. Co.

AIR CONDITIONING — HEATING & REFRIGERATION

258—Temperature, Moisture Control

Precision control of air temperature and moisture enable you to produce your product in any climate, at any season, according to six-page bulletin 122. The Type "A" air conditioner described, for drying or moistening of air, is shown in typical installations. Niagara Blower Co.

259—Propeller Fans

Three new models are among the 13 types of fans shown in 40-page bulletin A-100. It also describes three types of roof ventilators, unit heaters and intake air units, and includes specifications, dimensions, and performance figures on all equipment. Hartzell Propeller Fan Co.

260—Unit Heaters

Catalog CUH 846-A gives the complete story on Grid unit heaters. Catalog BC-1040 describes Grid blast coils for process drying. How the construction of the unit heaters prevents electrolytic corrosion is explained in booklet "Corrosion in Unit Heaters." D. J. Murray Manufacturing Co.

261—Steam Heating Systems

Five major types of steam heating systems, with and without control, and a full line of valves, traps, and steam power specialties are described in 19-page bulletin 110. It features the Selectotherm System which is an automatically controlled high vacuum steam heating system. Illinois Engineering Co., Div. of American Air Filter Co., Inc.

262—Woven Electric Heaters

Pre-Fab woven electric heaters are described in folder 1548 which illustrates typical uses and gives application data for this versatile heat source. Suggested uses such as for heating gearboxes, local comfort heating, and for preventing condensation are listed along with application data. Pre-Fab Heater Co., Subsidiary of Edwin L. Wiegand Co.

BOILERS & STEAM

263—Vertical Unit Boiler

More than 25 years of development, manufacturing, and application experience are reflected in the design of the Type VU-10 vertical-unit boiler described in 16-page bulletin VU 10-8. Advantages and design features are discussed. Combustion Engineering, Inc.

264—Refuse and Wood Burning

Engineering data concerning spreader stokers installed to burn refuse or wood are contained in 24-page booklet 505. Stationary, manual dumping, power dumping, and traveling grate installations having maximum capacities from 10,000 to 275,000 lb steam per hr, steam or compressed air operated, are described. Detroit Stoker Co.

265—Boiler Controls

Specifications for the fully automatic, all electric metering type packaged control for shop assembled boilers are given in four-page folder 53-1068-230. Schematic drawing shows a typical packaged control system for a combination oil or gas fired boiler. The Hays Corp.

266—Simplified Boilers

The new line of simplified Powermaster packaged automatic boilers in sizes 15 through 100 hp, light oil or gas, are discussed in eight-page bulletin 1230. Details of design and construction, a cutaway view, and sample specifications are given. Orr & Sembower, Inc.

372—General Catalog

A wealth of research, engineering, and manufacturing experience, gained since the founding of this company in 1880, is incorporated in the products described in four-page folder. Steam generators, heat transfer equipment, pressure vessels, valves, and fittings are shown. Henry Vogt Machine Co.

267—Pressure Equipment

One of the country's oldest manufacturers of equipment and accessories for

PRODUCT INDEX

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Air Conditioning — Heating & Refrigeration 102
Boilers & Steam 102
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NOTE—Each bulletin has a key number for your convenience in asking for a free, personal copy. Circle key numbers on Reply Card between pages 34/35 & 98/99.

plants piping steam, air, and gas under pressure, has published catalog 400, covering its line of separators, traps, and boiler trim. A condensation of the information in catalogs 500, 600, and 700, the booklet gives size and pressure tables and technical data. Wright-Austin Co.

268—Boiler Replacement

"What Every Business Man Should Know About Boilers," has been prepared to give executives a better understanding of boilers and a realization of the tremendous loss that industry is taking due to obsolete and inefficient steam generating equipment. Chances are two to one that your boiler is obsolete, according to this 14-page booklet. Superior Combustion Industries, Inc.

269—Heated and Cooled Gages

Four-page data unit 237 covers special purpose heated and cooled gages and valves which are said to solve the problem of getting accurate level readings of liquids that boil or surge—or liquids that are heavy and don't flow at normal temperature. Jerguson Gage & Valve Co.

270—Coal-Burning Installation

"Burning Bituminous Coal the Modern Way," contains 24-pages of case histories from industries of all sizes and types. Engineering survey results for equipment such as boilers, stokers, coal and ash handling units, and automatic controls, include annual fuel consumption and operating costs. Bituminous Coal Institute.

271—Draft Inducers

The biggest contribution to the cause of improved furnace operation in recent years has been the mechanical draft inducer, according to 12-page booklet I-52. Six causes of poor chimney draft are listed. L. J. Wing Mfg. Co.

272—Packaged Steam Generators

Construction of packaged steam generators is described in eight-page bulletin 1050. Auxiliary equipment is listed and a blueprint with dimensions of a typical boiler room is given. Ames Iron Works.

273—Coal Handling Equipment

Applications of coal handling equipment for the power plant, pictured in 40-page brochure 2410, illustrates the cumulative experience gained in thousands of installations over more than 75 years. Drawings show tested layouts for various operating conditions. Link-Belt Co.

274—Tube Cleaners

Bulletin 43 introduces a new geared tube cleaner for removing scale in heat exchanger and condenser tubes of ⅜ to 2½ in. ID. The unit is said to be particularly effective where conditions require low speed and extreme power. The Airetool Manufacturing Co.

275—Boiler Gaskets

Easy-reference flange gasket and boiler gasket dimension tables and bolting data are included in catalog AG-953. Shown are types for raised face, smooth face, crane-lap, and Van Stone joints, flange unions, male and female joints, and tongue and groove fittings for all standard makes of boilers. United States Gasket Co.

276—Small Capacity Boilers

Small boilers available in 15 to 40 hp for heating and processing are introduced in four-page bulletin AD-134. Advantages such as the new hinged front and rear doors, forced draft air system, four-pass construction, and electric control panel are shown. Cleaver-Brooks Co.

277—Condenser Tube Inserts

How to restore leaking condenser tubes to service by sealing off the deteriorated portion with inserts, is the subject of four-

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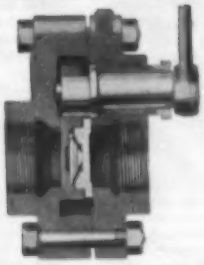
Quick-opening, also hand-wheel operated. Angle and "Y" types and combination units meeting ASME Code requirements for pressures up to 600 psi.



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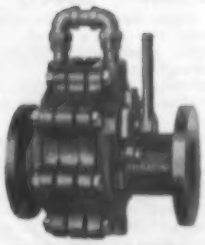

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bulletins

—Starts on page 102

page leaflet 500. Tube cleaners, expanders, and maintenance tools are listed. Thomas C. Wilson, Inc.

278—Boiler Cleaning

Four fact-filled pamphlets explain how this company's products will help you solve algae problems, increase boiler efficiency with use of the Ever Clean boiler process, remove rust, and prevent corrosion. North American Mogul Products.

279—Boilers and Equipment

Sixteen-page bulletin SB-50, "Erie City Boilers and Allied Equipment," describes custom designed steam generators for central station or industrial application. A number of water tube types available as well as a line of fire tube waste heat units are pictured. Erie City Iron Works.

280—Flue Dampers

Booklet 1-HEA on curtain type dampers for flue gas control explains what the damper is and does, construction, dimensions, installations, and gives case histories. Booklet shows drawings and photos of a variety of damper types. Heacon, Inc.

281—Tube Expanders

Rolling and flaring tube expanders and operating accessories are listed in eight-page catalog 60. Illustrations, specifications, and recommendations are included. The Gustav Wiedeke Co.

282—Atomizing Oil Burners

The cheapest grades of oil or tar can be completely atomized and efficiently burned with Type SA steam atomizing oil burners according to 16-page bulletin 21. Models for various special uses are described. Furnace design and construction for efficient operation is stressed. National Airoil Burner Co., Inc.

283—Soot Blowers

Bulletin 1137 gives complete information on the Model G9B blower which employs a fixed position rotating element to clean a large number of tubes by sweeping through a pre-determined arc. The bulletin suggests the various uses for boilers, superheaters, reheaters, economizers, heat exchangers, and oil stills. Diamond Power Specialty Corp.

284—Heavy-Oil Burner

Fuel savings is the theme of eight-page foldout AD-131 which describes the new "4" Hev-E-Oil burner. Illustrations show compactness and simplicity of design. Cleaver-Brooks Co.

285—Boiler Blowdown

"Boiler Blowdown Control," technical paper No. 128, is a reprint from **Industry and Power**, March 1954. Principal types of boiler blowdown are discussed, as well as various control methods necessary to assure production of pure steam and for keeping heat transfer surfaces free of scale and other objectionable deposits. W. H. & L. D. Betz.

286—Packaged Steam Generators

Basic construction and design features of plant assembled steam generators, with or without superheat, are presented in illustrated 20-page booklet P6-51-2. Includes tables of engineering specifications for units from 10,000 to 30,000 lb steam per hr and design pressures from 250 to 825 psi. Foster Wheeler Corp.

287—Power Plant Equipment

Custom engineered equipment for petroleum refineries, chemical plants, and power plants are pictured in use in these industries in 12-page bulletin E-1. Included are stills and towers, heat exchangers, reactors, oil chillers, crystallizers, steam generators, and ice making and refrigerating machinery. Henry Vogt Machine Co.

288—Boiler Baffles

"More Steam from Your Boilers," a four-page folder, explains how streamlined baffles are applied to all types and sizes of the company's boilers. Drawings indicate how they are installed in each specific unit to secure crossflow of gases. The Engineer Co.

289—Automatic Burner

Newly designed automatic burner, model PK-54, for oil, gas, and oil or gas, is described in four-page folder 430. Safety features are listed and the unit's integrated design is explained. For capacities to 42,000 lb steam per hour, the burner is described as a complete, automatic combustion unit including burner, blower, and controls. Peabody Engineering Corp.

290—Boiler Service Valves

Surface blow, bottom blow-off, water column blow-off, and connections are covered in 22-page bulletin E125, with complete specifications, materials, and dimensions of each type. Valve operation is explained by illustration. Fire protection valves are included. Everlasting Valve Co.

291—Boilers & Stokers

Over 88 years experience are embodied in the design and construction of Scotch Marine type portable boilers says 28-page catalog. Photographs and cross-sections illustrate various models ranging in capacities from 6 hp up to 25 hp. Details and features of underfed stokers designed especially for this type boiler are described. The James Leffel & Co.

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292—Firing Equipment

Over 50 years of leadership in the manufacture of industrial-commercial firing equipment is reflected in 19-page general catalog 3048. Schematic drawings, layouts of typical installations, cutaway views of burners and burner parts, and photographs of burners and installations are included. Petro Division.

293—Combustion Processes

Too much or too little air can have costly effects in combustion processes. Bulletin "Oxygen-Index of Combustion Processes" points out that by using oxygen itself as the criterion to proper combustion, greater over-all efficiency, and more economy can be realized. Arnold O. Beckman, Inc.

BUILDING MATERIALS & MAINTENANCE

294—Thread Compound

A data sheet gives complete information on C-5 "Hi-Temp" thread compound. A sample will be sent along with the data sheet. Felt Products Manufacturing Co.

295—Flooring

"Handbook of Building Maintenance," gives valuable information on keeping your plant in efficient working order. Instant-Use concrete floor patch is described

with suggestions for its use, along with other materials for repairing floors. Flexrock Company.

296—Repair Cements

Text and illustration in this 48-page handbook present repair methods for leaks in pipes, boilers, radiators, concrete, cinderblocks, and sheet and plate metal. Directory describes 12 repair cements and jobs they will do. Smooth-On Mfg. Co.

COMPRESSORS & BLOWERS

297—Compressors

Horizontal heavy duty air and gas compressors, Type T, are described in 15-page bulletin 728-8. Cross sections of crankshaft, inlet valve unloading system, compressor cylinder and valves, and the complete compressor add to the value of the booklet. Chicago Pneumatic Tool Co.

298—Rotary Compressors

Operation and construction of single-stage water-cooled rotary compressors and vacuum pumps, applicable to every air or gas handling requirement, are described in 12-page bulletin 16B8126. It gives general specifications along with typical air piping arrangement diagrams. Allis-Chalmers Mfg. Co.

CORROSION CONTROL

299—Transmission Line Corrosion

"Corrosion Control of Electrical Structures and Equipment," 17-pages, is designed to give practical painting information on all phases of transmission and distribution work. Photographs are used to show the protection that can be expected from this company's paint products. Subox, Inc.

DIESEL & GAS ENGINES

300—Dual Fuel Engines

In 36-page bulletin S-500-B757 are photographic examples of each application, together with vital statistics, case histories, and comments on fuel consumption for dual fuel engines. Each feature is treated separately. Worthington Corp.

ELECTRICAL EQUIPMENT

301—Air Circuit Breakers

Bulletin 5107-DR-1 contains four pages of facts, figures, features, and photographs on types KA, KB, KC, and LG Urelite air circuit breakers, and on weatherproof and dust-tight enclosures. I-T-E Circuit Breaker Co.

302—Power Transformers

Power transformers being built at the new mass production Rome, Ga. plant are described in 40-page booklet GEA-6108. It cites applications and features of standardized single phase and three phase units, ranging from 501 to 10,000 kva. General Electric Co.

303—Dry-Type Transformers

"Latest Developments in Dry-Type Transformers," seven-page catalog 153-A, presents the advantages of air-cooled units designed and constructed primarily for inside installations. Sorgel Electric Co.

304—Renewable Fuses

Sixteen-page bulletin S-40 describes the Economy DeLay renewable fuses which are said to give safe and dependable time-delay on overloads. For every requirement, these fuses have inexpensive links which are easily replaced. Economy Fuse & Manufacturing Co.

305—Power Factor Correction

Booklet 50B, 27 pages, describes the Unit-Cell Box Type Capacitors which offer easy-

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Yes, Dart Unions are the choice of boss pipers, master mechanics, foremen and superintendents not only because they *do the job* but because they go on easily — and can be used over and over again. Result: no leaks, no drip, no time or money wasted. Make them *your* buy!

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- *Leakproof* because precision machined to a true ball joint and spherically ground
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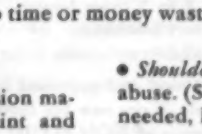

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bulletins

—Starts on page 102

to-install, economical means of correcting low power factor for large or small power consumers. Typical wire connections are shown. Sprague Electric Co.

306—Circuit Breakers

"What You Should Know About Circuit Breakers," 16-page manual 101, explains the operating principles of basic circuit breaker design. Included are simplified diagrams of three basic types. Heinemann Electric Co.

307—Commutators and Slip Rings

"Commutator and Slip Ring Maintenance," 39-page handbook, covers trouble shooting, brush maintenance and operating procedure, and general maintenance. Illustrations show the operations described. Ideal Industries, Inc.

308—Light Dimming Equipment

Light dimming equipment, available as packaged assemblies, is the subject of 12-page bulletin D651P. Described are units for different numbers of circuits requiring up to 2000 w each, and for various types of a-c operation. Wiring diagrams are included. The Superior Electric Co.

309—Flexible Conduit

Extra flexible Sealtite conduit for electrical wiring of machine tools and industrial equipment is pictured and described in four page pamphlet EF-531. It points out the fact that this liquid-tight, extra flexible conduit is approved for these uses by the Joint Industry Council. American Metal Hose Branch, American Brass Co.

ELECTRIC UTILIZATION

310—Variable Speed Motors

How variable speed motors are used to improve production is described in 16-page brochure 1797. In addition to describing advantages the booklet describes design theory and construction features. U. S. Electrical Motors, Inc.

311—Motor Control Center

Savings in space and expense and improved performance is explained in 12-page bulletin 170. Electrical and constructional details of these groups of combination motor starters and their components are fully described. Arrow-Hart & Hegeman Electric Co.

373—Motors

Advantages of the various types of motors made by this company are given in four-page folder 23. Descriptions of single-phase and polyphase motors are included along with a listing of their specifications. Wagner Electric Corp.

HEAT EXCHANGERS & WATER HEATERS

374—Pipe and Fin Coils

Revised second edition of the "Engineering Data Book on Pipe and Fin Coils" contains such information as calculation of pipe and fin coils, heat transfer coefficients for heating or cooling, factors for computing fin coil surfaces, recommended materials for heating or cooling, heat transfer factors at various air velocities, and Btu load limitations for cooling coil circuits. Rempe Co.

375—Heat Exchangers

Bulletin 120 describes the operation of the Aero Heat Exchangers used in cooling or controlling of temperatures of industrial liquids. It shows the operation of this equipment by means of diagrams and examples of application by installation photographs. Niagara Blower Co.

376—Unit Heaters

Catalog CUH 846-A gives the complete story on Grid unit heaters. Catalog BC-1040 describes Grid blast coils for process drying. How the construction of the unit heaters prevents electrolytic corrosion is explained in booklet "Corrosion in Unit Heaters." D. J. Murray Manufacturing Co.

312—Injection Water Heaters

Steam injection water heaters with the pressurizer piston for safe, quiet, automatic control are described in four-page pamphlet WH12A. How the unit saves space, time, fuel, installation, and maintenance costs is explained. Pick Manufacturing Co.

313—Water Heaters

A streamlined system of heating water and process liquids quickly and at low cost is explained in this bulletin. The Instant Heater described eliminates the need for reducers. Cross-sectional drawings explain how unit operates. Johnson Corp.

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314—Heaters

Horizontal and vertical heaters in steel, copper lined, copper-silicon, cement lined, clad and galvanized construction, as well as the low-flow design are each cataloged as to weights, dimensions, construction details, and capacities—with conversion tables, in 48-page catalog 18. The Patterson-Kelley Co., Inc.

INSTRUMENTS & CONTROLS

315—Gage Catalog

The four important questions to ask before you buy gages are listed in comprehensive 68-page catalog 64. Whether you need gages for replacement on operating equipment or for installation on new equipment, you will find complete information in this booklet. United States Gauge Div., American Machine and Metals, Inc.

316—Temperature Regulators

Bulletin 330 fully describes a simple, self-operating temperature regulator for plating, anodizing, bonderizing, pickling, cleaning and rinsing solutions. The Powers Regulator Co.

317—Temperature Regulators

Recommended installations of temperature regulators for instantaneous water heaters, storage water heaters, and forced air heating systems are shown in three line drawings in four-page folder 1008. Spence Engineering Co., Inc.

318—Temperature and Pressure Control

Through years of experience in instrument design and manufacture, this company has developed a specialized line of equipment for the recording and indicating of temperature and pressure to fill

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your specific requirements. Seven-page bulletin G-158-A shows typical examples of such equipment with lists of specifications. The Electric Auto-Lite Co., Instrument and Gauge Div.

377—Flow Meters

With an alarm control, the flow meters described in this bulletin have only three moving parts. How they operate to ring a bell, light a light, or activate a motorized valve is explained by means of illustrations. Henszey Co.

LUBRICATION

319—Force Feed Lubricator

Automatic force feed lubricator Model "94" described in 11-page booklet 94-C will pump against any steam or air pressure up to 1500 lb and will handle any grade of oil from the lightest mineral to the heaviest cylinder stock. Manzel Div. of Frontier Industries.

320—Non-Fluid Oil

This constructive bulletin explains the uses and advantages of Non-Fluid Oil. According to this booklet, it cannot clog fittings, it lubricates until entirely consumed, and will not separate under pressure. A free testing sample of the oil will be sent with the literature. New York & New Jersey Lubricant Co.

321—Oil Reclaimer

Subject of four-page folder R-347 is a self-contained, compact oil reclaimer for keeping industrial oils free from contaminants. In addition to describing how the process works, the bulletin suggests applications. The Hilliard Corp.

322—Diesel Lubrication

Written for everyone interested in the lubrication of diesels, "Lubrication of Diesel Engines," has been revised as technical bulletin B-1, 48-pages. It discusses diesel principles and design, types of engines in use, operating cycles, accessories and choice of correct diesel lubricants. Sun Oil Co.

323—Industrial Gear Lubricants

The new and improved line of extreme pressure industrial gear lubricants to replace Stanogear Leaded Lubricants and Stanogear EP Lubricants is discussed in six-page technical bulletin X-417. Every engineer with lubrication problems should have this booklet as general reference material. Standard Oil Co. (Indiana)

MATERIALS HANDLING & STORAGE

324—Storage Bins

If you specify vertical storage construction for handling flowable bulk materials, this ten-page foldout will help you visualize how this company's Super-Concrete Stave Storage Bins might meet your requirements. The Neff & Fry Co.

METALS & WELDING

325—Nickel Alloys

Helpful technical publications covering the many aspects of nickel alloys, and their applications, are listed in two bulletins. Instructions on how to order literature, free of charge, are included. The International Nickel Co., Inc.

PIPING, VALVES, & SPECIALTIES

326—Valves

Needle, globe, plug, check, relief, and special valves are described in 44-page catalog 352A. Units listed are made of various metals, and are suitable for instrumentation, processing industries, hydraulic systems, and industrial applications. Republic Manufacturing Co.

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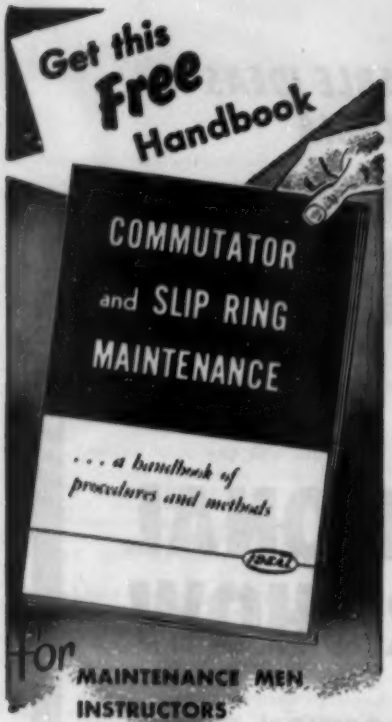

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THE methods and procedures described were developed by recognized, practicing maintenance authorities. They have been proven by conclusive evidence over many years in hundreds of operations. A concise guide, this 39-page handbook tells the practical operating man everything he needs to know about:

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- Brush maintenance and operating procedure.
- General maintenance procedure.

Dozens of illustrations show the operations described. Condensed data on IDEAL commutator and slip ring products is included.
Even if you do not have a regular maintenance training program, your people responsible for motor and generator maintenance need, and will do a better job, with the help of this handbook.

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bulletins

—Starts on page 102

327—High and Low Pressure Valves

Catalog 10 describes List 960 and 990 valves. The 960 is for a pressure range of 2000 lb at 100 F to 380 lb at 1000 F. The 990 is for higher pressures. According to the booklet, these valves offer extra protection against excessive stress with extra-strong stem and wedge-gate connection. Chapman Valve Manufacturing Co.

328—Rubber-Lined Pipe Joint

Nine-page handbook presents basic principle, design features, method of installation, plus parts and tools needed to utilize the Gaco rubber-lined pipe system. It compares cost of Gaco and flanged pipe installations. Gates Engineering Co.

329—Regulating Valves

Bulletin 1-A, 52 pages, gives complete information on a wide range of regulating valves for steam, water, air, gas, or oil. Illustrations, cross-sectional drawings, and specifications are included. Atlas Valve Co.

330—Prefabricated Conduit System

Introduced in four-page folder 5210 is a newly developed large diameter, prefabricated conduit system for protection of underground services. Prefabricated to job requirements, it contains piping for steam, condensate, water lines, fire lines, or process purposes all in place and insulated where required. The Ric-wiL Co.

331—Trapping Practice

Engineers concerned with steam traps should find 48-page catalog J a valuable source of data on recommended trapping practice. A maintenance section covers installation, preventive maintenance, trouble shooting, and repair. Armstrong Machine Works.

332—Valve Catalog

The various types of valves made by this company are pictured by means of blue-print drawings, cross sections, and photographs in bulletins 500—505, 508, and 600. Complete dimensions are listed in tables. W. S. Rockwell Co.

333—Separators & Purifiers

Live steam, exhaust steam, air and gas, and receiver type separators, and steam purifiers and exhaust heads are described in 24-page catalog 500. Charts give pressure drop, steam capacity, and air capacity. Wright-Austin Co.

334—Tank Calculator

Hydro-pneumatic tank calculator tells you instantly the best air-water ratio, most efficient pressure differential, exact amount withdrawn on any pressure drop, and resultant reserve. Printed on heavy board, the calculator operates on a slide rule principle. Automatic Control Co.

335—Pump Valves

Pump valves and graphite packings are described in 24-page brochure SC-510. Types, details of construction, design features, applications, how to order, and dimensions are included. Heaters for heating water by blending with steam are also presented. Sims Pump Valve Co., Inc.

336—Float Traps

If you are planning to install low, medium, or high pressure float or float and thermostatic traps, you will need this illustrated catalog sheet. According to the data sheet, once these valves are installed, there is no necessity for the breaking of any pipe connection for servicing. Hoffman Specialty Manufacturing Corp.

337—Mud Valves

Four-page folder 12-S points out the outstanding construction features for extra long service life and low maintenance of the 2000 psi W. P. and 3000 psi W. P. alloy steel mud valves. Interchangeability of parts is stressed along with simplicity of operation. Edward Valves, Inc. Subsidiary of Rockwell Mfg. Co.

338—Welded Floats

Units made of stainless steel, monel, and chrome plated steel, in spherical, eliptical, and cylindrical shapes are shown in eight-page bulletin 753. Sizes from 2 to 14 in. dia for pressures from vacuum to 4800 psi are listed with weights, buoyancies, and collapsing pressures. W. H. Nicholson & Co.

378—Pressure Pipe Coupling

Ring-Tite, the new coupling for Transite Pressure Pipe, is the subject of six-page folder TR-142A. It shows how the coupling goes together, points out installation time savings, and explains economies in service. Johns-Manville Corp.

Torque Wrenches

Both inch-pound and foot-pound torquers are described in this complete 68-page catalog. Types included are for a wide range of drive sizes with plain or ratchet head. **Please send requests directly to Proto Tool Co., Dept. IP, 12762 Santa Fe Ave., Los Angeles 54, Calif., with 10c.**

379—Rubber Linings

Application of rubber lining to prevent corrosion of tanks, pipes, and valves is discussed and pictured in four-page folder. In addition, two-page reprint tells how rubber lining can stop circulating pipe corrosion. La Favorite Rubber Manufacturing Company.

POWER TRANSMISSIONS — MECHANICAL

339—Belt Conveyor Design

Engineering data required to design a belt conveyor for any application are presented in 86-page catalog 852. The booklet, published to serve as a handbook on conveyor design, states that many problems can be answered by using a standardized unit. The Jeffrey Mfg. Co.

340—Flexible Couplings

Flexible couplings which never require lubrication are shown in 19-page bulletin 1009. Valuable engineering data for each type of coupling are given in table form. Lovejoy Flexible Coupling Co.

341—Eddy-Current Machinery

"Basic Principles of Eddy-Current Machinery," a section of 15-page bulletin GBI, explains the fundamental principles of generating torque by means of eddy-current devices. Another section, "Characteristics of Rotating Equipment," contains engineering data. Dynamatic Corp.

342—Power Transmission

Eight-page foldout describes a new concept of power transmission—the Poly-V Belt Drive. This drive is said to be a solution to matching problems and to provide greater changeability. Manhattan Rubber Div. of Raybestos-Manhattan Inc.

343—Rayon Belting

Transmission belting with rayon instead of cotton plies was proved in field applications for more than four years on jobs specially selected for their severity according to four-page folder A5163W. Uses

and advantages of Thor belting are listed. Goodyear Tire & Rubber Co.

344—Steel Collars

Steel shaft collars are shown in use on industrial lift trucks, printing presses, textile machinery, and other industrial equipment. Advantages of this type of collar are listed and a specification table is included. Standard Pressed Steel Co.

PUMPS

380—Turbo Pump

Each component of the type DE turbo pump is pictured and its design advantages explained in a six-page folder. The lubrication system is also described in detail. Typical uses are listed. The J. S. Coffin, Jr., Co.

381—Pump Package Systems

This catalog describes pump package systems including welded steel tanks in standard sizes of 50, 100, 175, 250, and 500 gal complete with all accessories. The Manajust Stroke adjustment for varying capacity when pump is not operating, and the Autajust for precise control of flow while pump is running are explained. Orchem Pump Div.

382—Proportioning Pumps

Design of the "K" pump, the result of long experience in the solution of proportioning problems, is shown in detail by means of a two-page foldout in five-page bulletin KP-54. Capacity and pressure tables will help you choose the pump for your particular requirements. Hills-McCanna Co.

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345—Opposed Impeller Pump

How opposed impellers balance axial thrust is covered in 12-page brochure 1502. Sizes from 2 to 4 in., with 2 to 8 stages, are presented for capacities to 1000 gpm, pressures to 1200 psig, and temperatures to 350 F. DeLaval Steam Turbine Co.

346—Packings

Darcova pumcups, which permit equipment to be operated at reduced speeds, are described in two bulletins: No. 4502 on Pumcups for air or hydraulic mechanisms; and 4401 on units for reciprocating pumps. How these units decrease maintenance and lower operating costs is described. Darling Valve & Mfg. Co.

347—Non-Clogging Pumps

Type U non-clogging pumps designed for handling liquids carrying large amounts of solids and foreign materials are described in 11-page bulletin 730-C. The specific uses of each type pump are given along with tables to help in selection. Weirman Pump Manufacturing Co.

348—Plunger Pumps

Graphically illustrated by photos, charts, and line drawings, 11-page bulletin W-44-B45 contains information about features, applications, ratings, dimensions, and specifications of the VTE, VTE-1, and VTE-2 types of Plunger Pumps. Units are designed for application in fields such as the petroleum industry, flooding, and salt water disposal. Worthington Corp.

349—Pumps

Condensed catalog "M" describes pumps for every purpose. Among those described are: turbine type pumps for use

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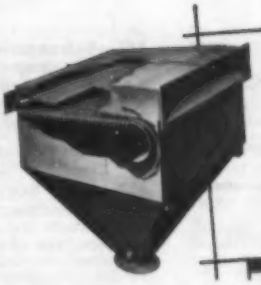

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bulletins

—Starts on page 102

with small capacities and high heads; and type 66U side suction centrifugal pumps. Aurora Pump Co., Div. of New York Air Brake Co.

383—Package Feeder

Proportioning pumps and package chemical feeding units are described in this four-page folder. With liquid ends available for about 85 percent of all chemical pumping requirements, the pump is designed for use where a controlled capacity of fluid is necessary. How the feeding unit can be connected to the piping of your plant and to the electrical control equipment is explained. Bird-Archer Co.

384—Rotary Gear Pumps

"How to Solve Pumping Problems," is the title of 36-page booklet 3060. In addition to presenting typical problems and their solutions, various types of rotary gear pumps are described. The major portion of the book is intended to serve as a data handbook. Geo. D. Roper Corp.

REFRACTORIES & INSULATION

350—Refractories

Charts which show at a glance the properties of refractory castables, plastics and mortars are featured in 20-page catalog R-22. Important information including recommendations for each is presented. Babcock and Wilcox Co., Refractories Div.

351—Refractories & Insulation

Catalogs R-52 through L-93, compiled in a binder, form an illustrated 40-page booklet showing where, when, and how to use various types of materials for industrial heat generation and processing equipment. Refractory & Insulation Corp.

352—Heat Resistant Concrete

Useful engineering data and information pertinent to the structural design of refractory and heat-resistant concrete is contained in illustrated 12-page booklet PP-5M. Universal Atlas Cement Co., Lumnite Div.

353—Aluminum Jacketing

One of the most frequent problems in the use of aluminum jacketing on insulated lines is how ells, tees, and bends should be weatherproofed. Data Sheet E-130 answers this question with a drawing which shows three practical methods for this part of the job. Childers Manufacturing Co.

354—Industrial Insulation

"J-M Products for the Process Industries," eight pages, is arranged as a ready reference for men responsible for the design, installation, and operation of process equipment. Johns-Manville Corp.

TURBINES & STEAM ENGINES

385—Steam Turbines

If you use steam for heating, cooking, or processing, you can get power at almost no cost with the use of a Wing steam turbine according to bulletin SW-1a. Construction of these units gives an almost infinite range of speeds, easy control by throttling, and the units are independent of any electric power failure. L. J. Wing Mfg. Co.

355—Steam Turbines

Fully-illustrated 24-page bulletin 1961 emphasizes the flexibility of design of the Type-S turbine which is said to make possible selection of the proper number of stages, governor, and controls to give maximum efficiency for your steam and operating conditions. Worthington Corp.

356—Multi-Stage Turbines

Smaller framed, multi-stage turbines are featured in six-page bulletin. Overspeed governor, governor valves, blades, diaphragms, and many other design features are discussed and illustrated. The Terry Steam Turbine Co.

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357—Turbine Speed Control

"Fundamentals of Turbine Speed Control," 32-page brochure H-21, is an educational piece intended to clarify the operation of common types of automatic speed control for steam turbines. Simplified diagrams illustrate operating principles of actual control systems. Elliott Co.

358—Steam Turbine Selection

Full details of this company's steam turbine are given in bulletin 135. Drawings and installation photographs point out the special features. How to save operating and maintenance costs by buying the right size for individual needs is explained. Coppus Engineering Corp.

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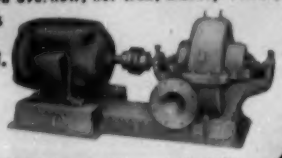

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359—Waste Treatment

How this company has solved waste treatment problems for such industries as electro-plating, refinery, gas, and metal finishing is treated in detail in six-page booklet 70-B. A handy bibliography serves as a reference for more information on waste treatment in each of the industries covered. Infilco, Inc.

WATER TREATMENT

360—Water Analysis

Published by a company engaged exclusively in the solution of industrial water conditioning problems, this 14-page brochure contains brief descriptions of testing and control equipment necessary for the more common water analyses. W. H. & L. D. Betz.

361—Water Purification

"Boiler Feedwater Treatment," 19-page bulletin BFT-1, covers Inversand zeolite softeners, color process chemical softeners, and demineralizing units, including silica removal by ion-exchange. Each process is explained by means of chemical formulas and flow diagrams. Hungerford & Terry, Inc.

362—Ion Exchange Material

Strongly basic anion exchanger is presented in 16-page bulletin 57. Includes complete data on physical characteristics, exchange capacity and regeneration technique. National Aluminate Corp.

363—Mixed Bed Demineralizing

"Automatic Mixed-Bed Demineralizing at the Albany Steam Plant," eight-page bulletin 3963 tells the story of the first fully automatic mixed-bed equipment to produce make-up water. A table shows the comparative cost of an evaporator plant and a demineralizer. The Permutit Co.

364—Water Conditioning

Conditioning for boiler, process, and general application is discussed in 20-page booklet 611A. A zeolite unit for manual and automatic operation is featured. In addition, chemical feed, zeolite-post treatment, zeolite-alkalinity neutralization, split-stream, and anion exchange dealkalization systems are explained. Elgin-Refinite Div. of Elgin Softener Corp.

365—Ion Exchangers

This 14-page booklet reviews generally the subject of ion exchange, established and potential applications. It gives advantages of the synthetic ion exchange resins and a bibliography of papers concerning their use. Rohm & Haas Co.

366—Water Softener

ZEO-FLO Sodium Zeolite Softener, a water softener specially designed for small and medium size industrial plants, laundries, and hospitals, is described in four-page folder 4505-A. How the softener has been simplified so that installation may be handled readily by the facilities of a small or medium sized plant is explained. Cochrane Corp.

367—pH Control

"Automatic pH Control in Water and Industrial Waste Treatment," eight pages, is a reissue of a paper delivered by R. T. Sheen, president of this company. Outlined are several typical systems of automatic pH control in boiler feed water treatment, using air- and motor-operated valves as well as controlled volume pumps to effect proper addition of chemicals. Milton Roy Co.

386—Chlorinizers

Chlorination—the modern way to prevent slime buildup in condensers and heat exchangers—saves you money if its right. But if dosage is too heavy, you run the risk of corrosion, according to application memo 840-J9. Chlorinizers available in three volumetric models for feeding from a few pounds to 6000 pounds per day are described. Builders-Providence, Inc.

387—Demineralization

"Demineralization Including Silica Removal by Ion Exchange," 26-page booklet 3803, describes applications, principles of operation, design features, and advantages, and gives recommendations and specifications for demineralizing and silica removal apparatus and synthetic resins. The Permutit Co.

368—Boiler Water Treatment

Difficulties caused through industrial water contamination are outlined in a 12-page catalog. Recommended water conditioning treatments for scale, sludge, corrosion, carryover and other boiler conditions, and efficient control methods are described. E. F. Drew & Co., Inc.

369—Deaerators

Spray-atomizing type units are shown in cross-section in four-page booklet 400. Function, design and operation, construction, outstanding features, and uses are discussed. American Water Softener Co.

370—Boiler Water Foam

Laboratory pictures in this four-page folder show how Concentrol controls boiler water foam. Examples of its use in various industries are given along with an explanation of foaming. Bird-Archer Co.

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Oct. 18-22	American Society of Civil Engineers (Convention)	Hotel Statler New York, N. Y.
Oct. 25-27	American Institute of Electrical Engineers (Machine Tool Conference)	Hotel Statler Detroit, Mich.
Nov. 1-5	American Welding Society (Fall Meeting)	Chicago, Ill.
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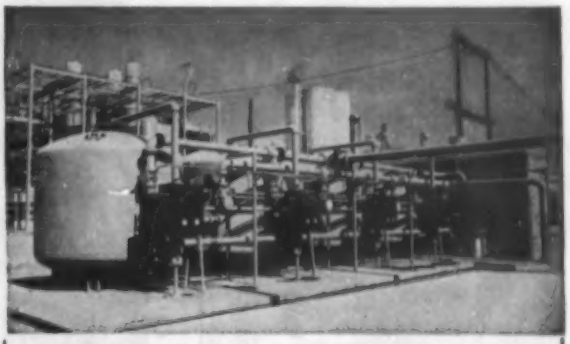

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